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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 20-1/1

“Radar Signal Processing”
(«Обработка РЛ сигналов»)

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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 20-1

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"Incoherent Scatter Spectral Theories-Part II: Modeling the Spectrum for Modes Propagating Perpendicular to"

Incoherent scatter (IS) spectral models for collisional and magnetized F-region plasmas are developed based on a general framework described in part I of this paper and on the statistics of simulated particle trajectories. In the simulations, a Langevin update equation is used to describe the motion of charge carriers undergoing Coulomb collisions. It is shown that random displacements of oxygen ions in the F-region can be characterized as a Brownian-motion process with Gaussian distributed displacement vectors. Electron displacements, on the other hand, are non-Brownian, and their statistics exhibit a dependence on the magnetic aspect angle. A numerical library of characteristic functions of electron displacements was constructed from the simulation data obtained for a set of plasma parameters typical of the equatorial F-region. Spectral models for the IS radar signals from F-region heights are constructed with one-sided Fourier transforms of the characteristic functions of electron and ion displacements. The models are valid at all magnetic aspect angles, including the zero aspect angle that corresponds to radar observations perpendicular to the ambient geomagnetic field . [J1]

"Instrumental CWLFM High-Range Resolution Radar in Millimeter Waveband for ISAR Imaging"

This paper shows a High-Range Resolution (HRR) Radar prototype development, transmitting in millimeter-wave band. The waveform selected to be used is the continuous-wave linear frequency modulation (CWLFM), which allows, at the same time, good range resolution, moderate unambiguous doppler range and reasonable operational range taking into account that high-frequency band is used. The radar prototype looks for High-Range Resolution (HRR) characteristics as well as flexibility, in order to obtain the best Inverse Synthetic Aperture Radar (ISAR) images possible depending on the applications and targets involved. That is, depending on the speed and target's trajectories, some radar features, such as transmitted bandwidth, modulator frequency or sampling frequency, play a key role in obtaining the best possible results while using lowest electrical requirements. [J2]

"Incoherent Scatter Spectral Theories-Part I: A General Framework and Results for Small Magnetic Aspect Angles"

A general framework for the incoherent scatter radar spectral theories is presented in terms of the generalized Nyquist theorem, Kramers-Kronig relations, and the characteristic functions of random charge-carrier displacements in the ionosphere. Specific spectral models for typical ionospheric conditions are derived and discussed. The discussions focus on the effect of Coulomb collisions in magnetized plasmas, which is a topic of current interest treated in further detail in the companion paper by the authors, as well as on different combinations of physical principles that can be invoked in the derivation of incoherent scatter spectral models. [J3]

"An Integrated Laser Radar Receiver Channel Utilizing a Time-Domain Walk Error Compensation Scheme"

An integrated receiver channel for a pulsed time-of-flight (TOF) laser rangefinder has been designed and fabricated in a 0.35-μm SiGe BiCMOS process. The receiver channel generates a timing mark for the TDC by means of a leading-edge timing discriminator that detects the crossover of the received pulse with respect to a set reference level. The walk error generated by the amplitude variation is compensated in the time domain on the basis of the measured dependence of the walk on the length of the received pulse. The measurement accuracy is ±15 ps with compensation within a dynamic range of 1:100000, and the single-shot precision and power consumption are 120 ps for a minimum detectable signal of ~1 μA and 115 mW, respectively. [J4]

"Investigation on Doppler Shift and Bandwidth of Backscattered Echoes From a Composite Sea

Surface"

In the general framework of the second-order small-slope approximation (SSA) (SSA-II), Doppler shifts of backscattered fields from time-varying sea surfaces are predicted at small and moderate incidence angles. The composite sea surface is modeled as a superposition of large-scale gravity waves and small-scale ripples. Here, the elevation of the large-scale surface component, on which each small facet travels along a closed orbit under the condition of the first-order approximation, is described by the coordinates of the small facets. The predicted Doppler shifts are compared with the results obtained by the small perturbation method (SPM), the geometrical optics method, the first-order SSA (SSA-I), and the two-scale scattering method (TSM). We can find that the predicted Doppler shifts for SPM and SSA-I in copolarized configuration are insensitive to the polarization state. However, the results obtained by SSA-II are consistent with those obtained by TSM and yield significant differences between HH and VV polarizations. Spectrum bandwidth is mainly induced by sea-surface orbit motions. In this paper, the formula of the spectrum bandwidth for the scattered echoes from the composite sea surface is also derived on the basis of TSM. The predicted bandwidths are compared with the Monte Carlo simulated results and the measured data. Furthermore, the dependences of the Doppler shift and the bandwidth on the parameters, such as the polarization, wind speed, radar frequency, etc., are also discussed. [J5]

"Multitemporal Image Change Detection Using Undecimated Discrete Wavelet Transform and Active Contours"

In this paper, an unsupervised change detection method for satellite images is proposed. Owing to its robustness against noise, the undecimated discrete wavelet transform is exploited to obtain a multiresolution representation of the difference image, which is obtained from two satellite images acquired from the same geographical area but at different time instances. A region-based active contour model is then applied to the multiresolution representation of the difference image for segmenting the difference image into the "changed" and "unchanged" regions. The proposed change detection method has been conducted on two types of image data sets, i.e., the synthetic aperture radar images and the optical images. The change detection results are compared with several state-of-the-art techniques. The extensive simulation results clearly show that the proposed change detection method consistently yields superior performance. [J6]

"Modeling the Configuration of HF Electrical Antennas for Deep Bistatic Subsurface Sounding"

In the frame of the European Space Agency's 2016 ExoMars mission, the Electromagnetic Investigation of the SubSurface (EISS) ground-penetrating radar has been designed and developed to perform deep soundings of the Martian subsurface from the surface. The EISS is designed to take advantage of the potential for bistatic radar investigations of the Martian subsurface between the fixed station (Lander) and the mobile platform (rover) and to characterize the 3-D structure and stratigraphy of the subsurface at depths ranging from 100 m to a few kilometers out to a 1-km radius around the lander. The EISS makes use of an electric dipole antenna made of two identical 35-m resistively loaded monopoles to transmit (and also receive in a monostatic mode) the high-frequency signal. However, the EISS's most innovative capability is its potential for bistatic operation, made possible by the accommodation of a small magnetic sensor on the rover (as initially planned for the ExoMars mission) which can measure the magnetic field (all three components) of the received waves whatever the direction and orientation of the rover. The aim of this paper is to show that the two monopoles of the antenna must be deployed on the surface in nearly opposite directions but not aligned to ensure good volume coverage around the transmitter. This paper is based on Finite Difference in Time Domain (FDTD) electromagnetic simulations. The simulated data have been used to study the impact of the angle between these two monopoles on the instrument performance. [J7]

"Ship Surveillance With TerraSAR-X"

Ship detection is an important application of global monitoring of environment and security. In order to overcome the limitations by other systems, surveillance with satellite synthetic aperture radar (SAR) is used because of its possibility to provide ship detection at high resolution over wide swaths and in all weather conditions. A new X-band radar onboard the TerraSAR-X (TS-X) satellite gives access to spatial resolution as fine as 1 m. In this paper, first results on the combined use of TS-X ship detection, automatic identification system (AIS), and satellite AIS (SatAIS) is presented. The AIS system is an effective terrestrial method for tracking vessels in real time typically up to 40 km off the coast. SatAIS, as a space-based system, allows almost global coverage for monitoring of ships since not all ships operate their AIS and smaller ships are not equipped with AIS. The system is considered to be of cooperative nature. In this paper, the quality of TS-X images with respect to ship detection is evaluated, and a first assessment of its performance for ship detection is given. The velocity of a moving ship is estimated using complex TS-X data. As test cases, images were acquired over the North Sea, Baltic Sea, Atlantic Ocean, and Pacific Ocean in Stripmap mode with a resolution of 3 m at a coverage of 30 km 100 km. Simultaneous information on ship positions was available from TS-X and terrestrial as well as SatAIS.

First results on the simultaneous superposition of SatAIS and high-resolution radar images are presented. [J8]

"Adaptive OFDM Radar for Target Detection in Multipath Scenarios"

We develop methods for detecting a moving target in the presence of multipath reflections, which exist, for example, in urban environments. We take advantage of the multipath propagation that increases the spatial diversity of the radar system and provides different Doppler shifts over different paths. We employ a broadband orthogonal frequency division multiplexing (OFDM) signal to increase the frequency diversity of the system as different scattering centers of a target resonate variably at different frequencies. To overcome the peak-to-average power ratio (PAPR) problem of the conventional OFDM, we also use constant-envelope OFDM (CE-OFDM) signaling scheme. First, we consider a simple scenario in which the radar receives only a finite number of specularly reflected multipath signals. We develop parametric measurement models, for both the OFDM and CE-OFDM signaling methods, under the generalized multivariate analysis of variance (GMANOVA) framework and employ the generalized likelihood ratio (GLR) tests to decide about the presence of a target in a particular range cell. Then, we propose an algorithm to optimally design the parameters of the OFDM transmitting waveform for the next coherent processing interval. In addition, we extend our models to study the aspects of temporal correlations in the measurement noise. We provide a few numerical examples to illustrate the performance characteristics of the proposed detectors and demonstrate the achieved performance improvement due to adaptive OFDM waveform design. [J9]

"Time-Series InSAR Applications Over Urban Areas in China"

In this study, we present the results achieved within the Dragon project, a cooperation program between the European Space Agency (ESA) and the National Remote Sensing Center of China (NRSCC), about monitoring subsidences and landslides in urban areas, analyzing cities growth and measuring the deformation of big man-made structures. Among the processed areas, we report here the main results we obtained in the test sites of Shanghai, Tianjin, Badong, and Three Gorges Dam. The techniques that have been used to process the data are original SAR interferometry (InSAR), Permanent Scatterers (PS-InSAR), Quasi-PS InSAR (QPS-InSAR), and a combination of coherent-uncoherent analysis. The results show that time-series InSAR techniques allow us to extract ground information with high spatial density and thus help us understanding the impact of urban development on terrain movements. [J10]

"The Seafloor: A Key Factor in Lidar Bottom Detection"

The environmental factors that determine the ability of airborne lidar bathymetry (ALB) to detect the seafloor are not well understood; however, water clarity is often considered the single factor for detection. A comparison of data from two different ALB systems (LADS-MKII and SHOALS-3000) of a small area offshore Gerrish Island, Maine, USA shows a striking correlation (95% overlap) in areas of no bottom detection that is independent of the tide status, the date of collection and the orientation of the survey flight. The laser measurements from the two ALB systems are compared to acoustic measurements of depth, seafloor slope, and backscatter from a Kongsberg EM3002 echosounder. The comparison shows that in water depths deeper than 7 m, there is a close correlation between the ALB detection patterns and bottom features. The study results indicate that lack of bottom detection by ALB does not necessarily indicate that water depths deeper than the surrounding areas have lidar strong bottom detection. No bottom detection in the study area actually reflects a change in bottom characteristics. [J11]

"Imaging Geodesy-Toward Centimeter-Level Ranging Accuracy With TerraSAR-X"

In this paper, we report on experiments to measure large-scale Earth surface displacements, such as those caused by solid Earth tides, with centimeter-level accuracy using TerraSAR-X radar images. With two totally different approaches, corner reflectors and image correlation techniques, we show the clear interrelation between the radar range measurements and the projection of the solid Earth tide motion vector onto the radar line of sight. Pixel location accuracies of up to 2.6-cm standard deviation can be achieved after a single calibration. We further demonstrate that solid Earth tides and tropospheric water vapor variations are the largest sources of ranging error if not compensated for. Alternatively, tropospheric water vapor can be estimated with centimeter accuracy using our proposed technique of synthetic aperture radar (SAR) image correlation and solid Earth motion compensation by the existing models. We also consider ionospheric delays which improve the results marginally in the X-band. Our results show the best ranging accuracies so far reported for spaceborne radar amplitude images and make TerraSAR-X-together with our simple compensation methodology-suitable for the imaging of centimeter-level Earth displacements. Absolute measurements of volcanoes or glaciers are possible without the use of ground equipment and without the use of SAR interferometry, thus avoiding the associated problems of phase ambiguity, phase unwrapping, and reference points. [J12]

"Cross-Range Scaling Algorithm for ISAR Images Using 2-D Fourier Transform and Polar Mapping"

This paper proposes a new method that solves the problem of inverse synthetic aperture radar image cross-range scaling by estimating the rotational velocity (RV) using the expansion-rotation-scale relationship between two range-Doppler (RD) images. This method is composed of three steps. The first step is preprocessing to construct 2-D Fourier transform images and initial polar-mapped images. In this step, two RD images are 2-D Fourier transformed to avoid the necessity of finding the rotation center; then, the transformed images are polar mapped with identical polar grids to convert rotation into translation in the θ-direction only. The second step is a coarse search that finds the angular shift that provides the maximum correlation between two polar images. The angular shift found is used as the initial relative rotation angle (RA), and the initial relative scaling factor (RSF) is calculated using the RV which is equal to the angular shift divided by the time delay between the images. The third step is the optimization of the relative RA using the Nelder-Mead approach, with the RSF updated using the relative RA derived during each iteration. In simulations using a Mig-25 aircraft, composed of ideal point scatterers, and the measured data from a Boeing 747-400, the targets were properly rescaled in the range-cross-range domain due to the accurate estimation of the RV. [J13]

"Hierarchical Segmentation of Polarimetric SAR Images Using Heterogeneous Clutter Models"

In this paper, heterogeneous clutter models are used to describe polarimetric synthetic aperture radar (PolSAR) data. The KummerU distribution is introduced to model the PolSAR clutter. Then, a detailed analysis is carried out to evaluate the potential of this new multivariate distribution. It is implemented in a hierarchical maximum likelihood segmentation algorithm. The segmentation results are shown on both synthetic and high-resolution PolSAR data at the X- and L-bands. Finally, some methods are examined to determine automatically the "optimal" number of segments in the final partition. [J14]

"Bias Correction and Doppler Measurement for Polarimetric Phased-Array Radar"

This paper discusses ways to avoid and/or mitigate biases in polarimetric variables inherent to agile-beam planar phased-array radars. Two bias-avoiding schemes produce unbiased estimates of the polarimetric backscattering covariance matrix which are then combined into bias-free polarimetric variables. One concerns full polarimetric measurements and calls for adjusting the amplitudes and phases of the array elements so that the transmitted field equals that generated by a mechanically steered polarimetric weather radar antenna; this is followed by an additional adjustment of the received fields. The second scheme is also applicable to full polarimetric measurements but involves adjustments only of the received fields. Crucial to both schemes is decoupling of the Doppler effects from the terms of the covariance matrix. It is a significant part of the bias issue that had not been previously addressed. A scheme to reduce bias applicable to nondepolarizing media (i.e., diagonal backscattering matrix) is also addressed; it calls for multiplication of the fields received by each dipole as opposed to a combination of multiplication and addition required for full correction. The schemes are applied to the alternate transmission and simultaneous reception polarimetric mode and the simultaneous transmission and simultaneous reception mode. [J15]

"An Internal Calibration Scheme for Polarimetric Synthetic Aperture Radar System"

Two important aspects of internal calibration of polarimetric synthetic aperture radar are discussed, i.e., system gain calibration and individual transmit/receive module (TRM) calibration. System gain variation is measured, utilizing the internal calibration loop. A dual-channel TRM gain and phase calibration is carried out using orthogonal phase coding, where a signal of individual TRM is phase encoded according to a set of orthogonal codes in order to be separated from the composite calibration signal of all TRMs. Calibration results are developed both theoretically and through simulation in the case of TRM failure. Error introduced by phase-shifter toggling inaccuracy is discussed. A cross talk model is used to investigate the effect of imperfect isolation between the two polarization channels of each TRM on the calibration error. [J16]

"Three-Dimensional GPR Ray Tracing Based on Wavefront Expansion With Irregular Cells"

A new ray-tracing method in 3-D heterogeneous isotropic media is proposed based on the bilinear travel-time interpolation and wavefront group marching method (GMM). In this method, an irregular cell discretization scheme is used to accurately describe arbitrarily undulant interfaces in a model. The ray tracing is carried out by forward-backward processing. In the forward step, the travel time in an irregular cell is expressed in terms of the bilinear interpolation of the known travel times on the cell's surfaces. Then, the wavefront is evolved from the source to the whole computational domain by using the newly developed travel-time solver and the fast wavefront expansion GMM. In the backward step, each ray path is traced from the receiver by finding the

intersection points of potential ray propagation vectors with the surfaces of the relevant cells. The same travel-time solver is used to compute the candidate intersection points on all surfaces of each relevant cell, and the point with the minimum travel time is selected as a ray point from which the similar step is continued until the sources are found. Several numerical experiments are presented to demonstrate that the new algorithm is accurate, efficient, and robust. [J17]

"Experimental Study on Radiometric Performance of Synthetic Aperture Radiometer HUT-2D-Measurements of Natural Targets"

This paper describes the analysis of L-band radiometric measurement data gathered with the synthetic aperture radiometer HUT-2D during several ground-based and airborne measurement campaigns. The radiometric data are analyzed from the instrument's performance point of view, aiming to verify the theoretical performance of an instrument of this kind and to assess the performance of the HUT-2D radiometer system in particular. The data sets considered for the study consist of measurements of well-known natural targets, such as cosmic background radiation, and measurements of pure water scenes, the brightness temperature of which is possible to model based on in situ measurements. We define four figures of merit, which are applicable for synthetic aperture radiometers. These are radiometric resolution, image bias, pixel-to-pixel random error, and temporal stability. Then, we use the selected data sets to assess these in the case of HUT-2D. The experimental results are discussed and compared to the theoretical values, where applicable. Also, we discuss possibilities to improve the presented performance. The main results of this paper are the consolidated performance parameters of the HUT-2D instrument. We study and discuss the properties of the error components related to the technology in a general level, and study the scalability of the errors as a function of the measured targets. In particular, the stability of the direction-dependent error component is pointed out, and a mitigation guideline is proposed. [J18]

"Extended Target Tracking Using Polynomials With Applications to Road-Map Estimation"

This paper presents an extended target tracking framework which uses polynomials in order to model extended objects in the scene of interest from imagery sensor data. State-space models are proposed for the extended objects which enables the use of Kalman filters in tracking. Different methodologies of designing measurement equations are investigated. A general target tracking algorithm that utilizes a specific data association method for the extended targets is presented. The overall algorithm must always use some form of prior information in order to detect and initialize extended tracks from the point tracks in the scene. This aspect of the problem is illustrated on a real life example of road-map estimation from automotive radar reports along with the results of the study. [J19]

"Wireless SAW Temperature Sensor System for High-Speed High-Voltage Motors"

This paper gives an overview on the system development of a wireless surface acoustic wave (SAW) temperature measurement application in high-speed high-voltage motors. The measurement location of interest is on the rotor in the vicinity of the copper squirrel cage. To fit the sensor in a 4 mm bore, a custom packaging with outer dimensions of 10.0 Ч 3.1 Ч 2.0 mm3has been developed. For the purpose of interrogation a mechanically robust metal slot antenna has been designed to withstand rotation speeds up to 15 000 rpm. As the sensor interacts only during a very short time of a few 100 μs with the reader antenna a fast frequency modulated continuous wave (FMCW) reader was developed. The reader operates in the ISM band of 2.4 GHz and achieves a typical sweep time for data acquisition of 100 μs. The sensor system has been tested both in test bed and real engine conditions and performed stable read outs, although in the real engine signal behavior is disturbed by reflections and possibly electromagnetic field bursts caused by the power converter. [J20]

"A Transceiver Module for FMCW Radar Sensors Using 94-GHz Dot-Type Schottky Diode Mixer"

In this study, we fabricated a 94-GHz transceiver module for a millimeter-wave (MMW) frequency modulation continuous wave (FMCW) radar sensor. The transceiver modules consist of a waveguide voltage-controlled oscillator (VCO) and Rx module using a single balanced mixer. We designed a mixer with a conversion loss of 6.4 dB, without using an amplifier. Also, the waveguide VCO consisted of an InP Gunn diode, a varactor diode, two bias posts with LPF, and a Magic Tee for the MMW radar transceiver. The fabricated VCO has a tuning range of 1280 MHz by a varactor bias of 0~20 V, 1.69% linearity range of 680 MHz, and current consumption of 154 to 157 mA. The completed module has a good conversion loss of 10.6 dB with an LO power of 11.4 dBm at 94 GHz. With this RF and LO input power, the conversion loss was maintained between 10.2-11.5 dB in the RF frequency range of 93.67-94.95 GHz. [J21]

"Radar Sensor Network Using a Set of New Ternary Codes: Theory and Application"

In the radar sensor network (RSN), the interferences among different radar sensors can be effectively reduced

when waveforms are properly designed. In this paper, we perform some theoretical studies on coexistence of phase coded waveforms in the RSN. We propose a new ternary codes-optimized punctured zero correlation zone sequence-pair set (ZCZPS)-and analyze their properties. Applying the new ternary codes and equal-gain combination technique to the RSN, we study the detection performance versus different numbers of radar sensors under the different conditions. The simulation results show that the RSN using our optimized punctured ZCZPS performs better than the RSN using the same number of common codes such as the Gold codes and much better than the single radar system no matter whether or not the Doppler shift is considered. [J22]

"New Method of Sparse Parameter Estimation in Separable Models and Its Use for Spectral Analysis of Irregularly Sampled Data"

Separable models occur frequently in spectral analysis, array processing, radar imaging and astronomy applications. Statistical inference methods for these models can be categorized in three large classes: parametric, nonparametric (also called "dense") and semiparametric (also called "sparse"). We begin by discussing the advantages and disadvantages of each class. Then we go on to introduce a new semiparametric/sparse method called SPICE (a semiparametric/sparse iterative covariance-based estimation method). SPICE is computationally quite efficient, enjoys global convergence properties, can be readily used in the case of replicated measurements and, unlike most other sparse estimation methods, does not require any subtle choices of user parameters. We illustrate the statistical performance of SPICE by means of a line-spectrum estimation study for irregularly sampled data. [J23]

"NL-InSAR: Nonlocal Interferogram Estimation"

Interferometric synthetic aperture radar (SAR) data provide reflectivity, interferometric phase, and coherence images, which are paramount to scene interpretation or low-level processing tasks such as segmentation and 3-D reconstruction. These images are estimated in practice from a Hermitian product on local windows. These windows lead to biases and resolution losses due to the local heterogeneity caused by edges and textures. This paper proposes a nonlocal approach for the joint estimation of the reflectivity, the interferometric phase, and the coherence images from an interferometric pair of coregistered single-look complex (SLC) SAR images. Nonlocal techniques are known to efficiently reduce noise while preserving structures by performing the weighted averaging of similar pixels. Two pixels are considered similar if the surrounding image patches are "resembling." Patch similarity is usually defined as the Euclidean distance between the vectors of graylevels. In this paper, a statistically grounded patch-similarity criterion suitable to SLC images is derived. A weighted maximum likelihood estimation of the SAR interferogram is then computed with weights derived in a data-driven way. Weights are defined from the intensity and interferometric phase and are iteratively refined based both on the similarity between noisy patches and on the similarity of patches from the previous estimate. The efficiency of this new interferogram construction technique is illustrated both qualitatively and quantitatively on synthetic and true data. [J24]

"Spatial-Range Mean-Shift Filtering and Segmentation Applied to SAR Images"

The mean-shift (MS) algorithm is applied for reducing speckle noise and segmenting synthetic aperture radar (SAR) images. Two coastal images acquired by Envisat's advanced SAR (ASAR) [European Space Agency (ESA)] are used. Studies of the MS parameters are carried out according to the desired product: a speckle filtered image where textures and edges are preserved, or a segmented image, where land and sea are distinguished, as a previous stage for obtaining a land mask and detecting the coastal line. In all cases, Gaussian kernels are used. Speckle filtering results are compared with those obtained using uniform kernels, proving that the former provides better results than the latter. A segmentation approach based on the positions and frequencies at which the MS converges is applied. The use of a combined spatial-range processing and the corresponding bandwidths makes the MS suitable for the two proposed problems. The solid theoretical basis of this procedure allows designing a guided search of the best parameters according to the desired solution, avoiding a tedious trial-and-error process. Although the used images have different characteristics, results prove that similar sets of parameters can be used, showing some degree of robustness with respect to the image, for a given sensor and image acquisition mode. [J25]

"Impact of DEM-Assisted Coregistration on High-Resolution SAR Interferometry"

Image alignment is a crucial step in synthetic aperture radar (SAR) interferometry. Interferogram formation requires images to be coregistered with an accuracy of better than a few tenths of a resolution cell to avoid significant loss of phase coherence. In conventional interferometric precise coregistration methods for full-resolution SAR data, a 2-D polynomial of low degree is usually chosen as warp function, and the polynomial parameters are estimated through least squares fit from the shifts measured on image windows. In case of rough

topography or long baselines, the polynomial approximation may become inaccurate, leading to local misregistrations. These effects increase with spatial resolution of the sensor. An improved elevation-assisted image-coregistration procedure can be adopted to provide better prediction of the offset vectors. This approach computes pixel by pixel the correspondence between master and slave acquisitions by using the orbital data and a reference digital elevation model (DEM). This paper aims to assess the performance of this procedure w.r.t. the "standard" one based on polynomial approximation. Analytical relationships and simulations are used to evaluate the improvement of the DEM-assisted procedure w.r.t. the polynomial approximation as well as the impact of the finite vertical accuracy of the DEM on the final coregistration precision for different resolutions and baselines. The two approaches are then evaluated experimentally by processing high-resolution SAR data provided by the COnstellation of small Satellites for the Mediterranean basin Observation (COSMO/SkyMed) and TerraSAR-X missions, acquired over mountainous areas in Italy and Tanzania, respectively. Residual-range pixel offsets and interferometric coherence are used as quality figure. [J26]

"Unsupervised Spatiotemporal Mining of Satellite Image Time Series Using Grouped Frequent Sequential Patterns"

An important aspect of satellite image time series is the simultaneous access to spatial and temporal information. Various tools allow end users to interpret these data without having to browse the whole data set. In this paper, we intend to extract, in an unsupervised way, temporal evolutions at the pixel level and select those covering at least a minimum surface and having a high connectivity measure. To manage the huge amount of data and the large number of potential temporal evolutions, a new approach based on data-mining techniques is presented. We have developed a frequent sequential pattern extraction method adapted to that spatiotemporal context. A successful application to crop monitoring involving optical data is described. Another application to crustal deformation monitoring using synthetic aperture radar images gives an indication about the generic nature of the proposed approach. [J27]

"Multiobjective Optimization of OFDM Radar Waveform for Target Detection"

We propose a multiobjective optimization (MOO) technique to design an orthogonal-frequency-division multiplexing (OFDM) radar signal for detecting a moving target in the presence of multipath reflections. We employ an OFDM signal to increase the frequency diversity of the system, as different scattering centers of a target resonate variably at different frequencies. Moreover, the multipath propagation increases the spatial diversity by providing extra "looks" at the target. First, we develop a parametric OFDM radar model by reformulating the target-detection problem as the task of sparse-signal spectrum estimation. At a particular range cell, we exploit the sparsity of multiple paths and the knowledge of the environment to estimate the paths along which the target responses are received. Then, to estimate the sparse vector, we employ a collection of multiple small Dantzig selectors (DS) that utilizes more prior structures of the sparse vector. We use the $\ell 1$-constrained minimal singular value ($\ell 1$-CMSV) of the measurement matrix to analytically evaluate the reconstruction performance and demonstrate that our decomposed DS performs better than the standard DS. In addition, we propose a constrained MOO-based algorithm to optimally design the spectral parameters of the OFDM waveform for the next coherent processing interval by simultaneously optimizing two objective functions: minimizing the upper bound on the estimation error to improve the efficiency of sparse-recovery and maximizing the squared Mahalanobis-distance to increase the performance of the underlying detection problem. We provide a few numerical examples to illustrate the performance characteristics of the sparse recovery and demonstrate the achieved performance improvement due to adaptive OFDM waveform design. [J28]

"Low-Power Technique for SRAM-Based On-Chip Arbitrary-Waveform Generator"

A low-power technique for a static random-access memory (SRAM)-based on-chip arbitrary-waveform generator (AWG) is proposed for two types of analog-signal-processing applications: multiresolution spectrum sensing and matched filter. The SRAM has an embedded address generator to limit the operation in a sequential-access mode of the AWG. Then, the power consumption of the AWG is analyzed according to the operation modes in multiresolution and multiwaveform spectrum-sensing functions. The low-power technique reduces power by 18% of the SRAM and the address generator and by about 2.2% of the entire AWG at a 1.8-V supply voltage. The AWG is fabricated in a 0.18-μm CMOS technology and demonstrates a chirp signal and a Daubechies wavelet with a 45-dBc spurious-free dynamic range and a cross-correlation factor of 0.96-0.988 with ideal signals. [J29]

"Wideband MIMO Systems: Signal Design for Transmit Beampattern Synthesis"

The usage of multi-input multi-output (MIMO) systems such as a MIMO radar allows the array elements to transmit different waveforms freely. This waveform diversity can lead to flexible transmit beampattern synthesis, which is useful in many applications such as radar/sonar and biomedical imaging. In the past literature most

attention was paid to receive beampattern design due to the stringent constraints on waveforms in the transmit beampattern case. Recently progress has been made on MIMO transmit beampattern synthesis but mainly only for narrowband signals. In this paper we propose a new approach that can be used to efficiently synthesize MIMO waveforms in order to match a given wideband transmit beampattern, i.e., to match a transmit energy distribution in both space and frequency. The synthesized waveforms satisfy the unit-modulus or low peak-to-average power ratio (PAR) constraints that are highly desirable in practice. Several examples are provided to investigate the performance of the proposed approach. [J30]

"Differential Absorption Lidar to Measure Subhourly Variation of Tropospheric Ozone Profiles"

A tropospheric ozone Differential Absorption Lidar system, developed jointly by The University of Alabama in Huntsville and the National Aeronautics and Space Administration, is making regular observations of ozone vertical distributions between 1 and 8 km with two receivers under both daytime and nighttime conditions using lasers at 285 and 291 nm. This paper describes the lidar system and analysis technique with some measurement examples. An iterative aerosol correction procedure reduces the retrieval error arising from differential aerosol backscatter in the lower troposphere. Lidar observations with coincident ozonesonde flights demonstrate that the retrieval accuracy ranges from better than 10% below 4 km to better than 20% below 8 km with 750-m vertical resolution and 10-min temporal integration. [J31]

"Mode Effect on Direct Wave in Single-Hole Borehole Radar"

In this paper, we investigate the influence of radar sonde eccentricity on a direct wave between a transmitting and a receiving antenna in a single-hole borehole radar measurement. We analyze the direct wave using an analytical method with the approximated solution of branch cut integrals and that of residues of poles. According to our calculation, at high frequencies above 200 MHz, guided waves, which are caused by the poles, play a vital role in the direct wave. We found that the most important pole is the HE11mode one, which is excited only when the antenna is eccentered in the borehole. We show that this causes artificial noise in the moving average subtraction, which is a common signal processing method used to remove the direct wave. In a laboratory experiment with a ground plane, we confirmed the excitation of the guided waves when the antenna was eccentered. In field experiments in granite, we conducted a special experiment, in which the location and rotation of the radar sonde were controlled mechanically. We found the excitation of the HE11mode at high frequencies when the sonde was noncentered by 1.7 cm in a borehole. These effects are also predicted in a theoretical analysis. [J32]

"Wireless Sensing of Human Respiratory Parameters by Low-Power Ultrawideband Impulse Radio Radar"

The simultaneous tracking of the chest respiratory rate and amplitude of human beings using a low-power ultrawideband (UWB) impulse radio signal is investigated for the application of sleep apnea monitoring. The measurement of respiratory amplitude, in addition to the breathing rate, is crucial for sleep apnea assessment which requires, among other things, the accurate estimation of tidal volume per minute. Backscattered UWB impulse radio signals from a human subject are detected in the time domain to calculate the chest displacements in this paper. Since the pulse disposition in time is linearly related to the chest movement, the amplitude of the chest movement can be extracted accurately without calculation approximations normally used in many of the existing methods. The multipeak detection of the pulse disposition method, instead of using only the single pulse peak detection, is also proposed to improve the accuracy of the calculation further. The experiments are carried out on four human subjects with different sizes and genders. The correlation of the chest movements' amplitude and breathing rate between the simultaneously measured results obtained by our method and by the respiratory chest band is very good. [J33]

"Using Scaled Models for Wind Turbine EM Scattering Characterization: Techniques and Experiments"

Characterizing the Radar Cross Section (RCS) wind turbine structures is the first step to mitigate the impact of wind farms on radar operations. An efficient technique based on scaled wind turbine models in both laboratory and computer environment is studied. The scaled 3-D computer model is used in different electromagnetic solvers to predict the RCS properties, given radar parameters. The scaled laboratory model is placed in a controlled laboratory environment, and accurate RCS measurements of the scaled models are used to emulate wind turbine radar signatures. Comparisons between approximate numeric model prediction and measurement results are presented, and a method for predicting full-size wind turbine scattering properties based on scaled models is discussed. [J34]

"On the Discrimination of Radar Signatures of Atmospheric Gravity Waves and Oceanic Internal Waves on Synthetic Aperture Radar Images of the Sea Surface"

Synthetic aperture radar (SAR) images acquired over the ocean frequently show sea wave-like patterns that have wavelengths well above those of ocean surface waves and that are sea surface signatures of oceanic internal waves (OIWs) or of atmospheric gravity waves (AGWs). However, it is often difficult to decide whether they result from the first or the second kind of waves, which has led many investigators to misinterpret SAR images of the sea surface. Based on solitary wave and radar imaging theories of AGWs and OIWs, we present criteria that help distinguish between them. However, there are cases where these criteria, which are based solely on the shape and structure of the features visible on the SAR images, yield ambiguous results. In these cases, one must resort to additional information on the generation of AGWs and OIWs, which are listed in this paper. [J35]

"On the Use of Anisotropic Covariance Models in Estimating Atmospheric DInSAR Contributions"

Stochastic models are often used to describe the spatial structure of atmospheric phase delays in differential interferometric synthetic aperture radar (DInSAR) data. Synthetic aperture radar interferograms often exhibit anisotropic atmospheric signals. In view of this, the use of anisotropic models for atmospheric phase estimation is increasingly advocated. However, anisotropic models lead to increased computational complexity in estimating the correlation function parameters with respect to the isotropic case. Moreover, the performance is degraded when dealing with DInSAR techniques involving only a few sparse points usable for computations, as in the case of persistent scatterer interferometry applications, particularly when this estimation has to be done in an automated way on many interferograms. In the present work, we propose some observations about the actual advantage given by anisotropic modeling of atmospheric phase in the case of sparse-grid point-target DInSAR applications. Through analysis of simulated data, we observe that an improvement in the performances of kriging reconstruction approaches can be obtained only when sufficient sampling densities are available. In critical sampling conditions, automated methods with reasonable computational cost may improve their performance if external information on the atmospheric phase screen field is available. [J36]

"Fractional QCQP With Applications in ML Steering Direction Estimation for Radar Detection"

This paper deals with the problem of estimating the steering direction of a signal, embedded in Gaussian disturbance, under a general quadratic inequality constraint, representing the uncertainty region of the steering. We resort to the maximum likelihood (ML) criterion and focus on two scenarios. The former assumes that the complex amplitude of the useful signal component fluctuates from snapshot to snapshot. The latter supposes that the useful signal keeps a constant amplitude within all the snapshots. We prove that the ML criterion leads in both cases to a fractional quadratically constrained quadratic problem (QCQP). In order to solve it, we first relax the problem into a constrained fractional semidefinite programming (SDP) problem which is shown equivalent, via the Charnes-Cooper transformation, to an SDP problem. Then, exploiting a suitable rank-one decomposition, we show that the SDP relaxation is tight and give a procedure to construct (in polynomial time) an optimal solution of the original problem from an optimal solution of the fractional SDP. We also assess the quality of the derived estimator through a comparison between its performance and the constrained Cramer Rao lower Bound (CRB). Finally, we give two applications of the proposed theoretical framework in the context of radar detection. [J37]

"Energy-Efficient Precoding for Multiple-Antenna Terminals"

The problem of energy-efficient precoding is investigated when the terminals in the system are equipped with multiple antennas. Considering static and fast-fading multiple-input multiple-output (MIMO) channels, the energy-efficiency is defined as the transmission rate to power ratio and shown to be maximized at low transmit power. The most interesting case is the one of slow fading MIMO channels. For this type of channels, the optimal precoding scheme is generally not trivial. Furthermore, using all the available transmit power is not always optimal in the sense of energy-efficiency [which, in this case, corresponds to the communication-theoretic definition of the goodput-to-power (GPR) ratio]. Finding the optimal precoding matrices is shown to be a new open problem and is solved in several special cases: 1. when there is only one receive antenna; 2. in the low or high signal-to-noise ratio regime; 3. when uniform power allocation and the regime of large numbers of antennas are assumed. A complete numerical analysis is provided to illustrate the derived results and stated conjectures. In particular, the impact of the number of antennas on the energy-efficiency is assessed and shown to be significant. [J38]

"Two-Frequency Radar Experiments for Sounding Glacier Ice and Mapping the Topography of the Glacier Bed"

We performed airborne experiments using 150- and 450-MHz radars to measure ice thickness on the Greenland ice sheet. Our objectives were to investigate to what degree surface clutter obscures the basal echo when airborne measurements are made at different elevations and at different frequencies. We also explored interferometric techniques for processing the data to form swath measurements of ice thickness. We found that surface clutter was minimal for either frequency when operated at low aircraft elevations (500 m above the ice sheet surface) or over benign regions of the ice sheet. Because signal-to-clutter ratios were favorable, we found that we could retrieve the swath measurements of ice thickness at both frequencies using an interferometric technique. At high elevation, surface clutter degraded the 150-MHz signal, but the nadir ice thickness was still retrievable. The basal return in high-elevation 450-MHz data was detectable only after additional beam-steering techniques were applied to the data to reduce the surface clutter signal. Results suggest that interferometric cross-track ice-thickness measurements can be successfully made given a sufficient number of antenna elements driven at either 150 or 450 MHz and flown at both high and low elevations over the interior ice sheet. [J39]

"Radar HRRP Statistical Recognition With Local Factor Analysis by Automatic Bayesian Ying-Yang Harmony Learning"

Radar high-resolution range profiles (HRRPs) are typical high-dimensional, non-Gaussian and interdimension dependently distributed data, the statistical modelling of which is a challenging task for HRRP based target recognition. Assuming the HRRP data follow interdimension dependent Gaussian distribution, factor analysis (FA) was recently applied to describe radar HRRPs and a two-phase procedure was used for model selection, showing promising recognition results. Besides the interdimensional dependence, this paper further models the non-Gaussianity of the radar HRRP data by local factor analysis (LFA). Moreover, since the two-phase procedure suffers from extensive computation and inaccurate evaluation on high-dimensional finite HRRPs, we adopt an automatic Bayesian Ying-Yang (BYY) harmony learning, which determines the component number and the hidden dimensionalities of LFA automatically during parameter learning. Experimental results show incremental improvements on recognition accuracy by three implementations, progressively from a two-phase FA, to a two-phase LFA, and then to an automatically learned LFA by BYY harmony learning. [J40]

"A Novel Imaging Method for Fast Rotating Targets Based on the Segmental Pseudo Keystone Transform"

Fast rotating targets such as gimbaled antennas or propeller blades may cause migration through resolution cells (MTRC) of the high-resolution range profile during the imaging time, which makes the inverse synthetic aperture radar image smeared. To solve this problem, a novel imaging method for fast rotating targets is proposed in this paper. The method is based on the segmental pseudo Keystone transform, which is designed to realize MTRC correction. The fast realization is achieved by employing the discrete match Fourier transform, which makes the algorithm feasible and simple. Experiments with simulated radar data demonstrate the performance of the proposed method. [J41]

"Sparse Reconstruction From GPR Data With Applications to Rebar Detection"

The problem of detecting and localizing 2-D thin scatterers (i.e., elongated scatterers whose cross sections are small in terms of the probing wavelength) from scattered field measurements is considered. To this end, a linear model that neglects mutual scattering and is based on a distributional representation of the unknown is established. An improved imaging technique based on a minimization algorithm, which takes advantage of the inherent sparseness of the considered ground-penetrating radar scenario, is presented and compared to a classical migration algorithm. The comparison is achieved for both synthetically generated and experimental data collected in realistic conditions under a multimonostatic/multifrequency configuration. [J42]

"A Microphysics-Based Simulator for Advanced Airborne Weather Radar Development"

Incorporating dual-polarized operation and microphysics-based processing is becoming a challenge to future scientific and commercial airborne weather radars. This paper introduces a Monte Carlo simulation-based approach to address the theoretical basis and uncertainties of hydrometeor scattering along with sensor platform properties. Detailed characterizations of mixed-phase aviation hydrometeor hazards (rain, snow, hail, and mixtures) and the impact of melting on polarimetric radar signature at X-band frequency are discussed. A "single resolution cell" Monte Carlo dual-polarization variable simulation technique is described and then applied in different radar scanning scenarios based on numeric weather prediction model output weather fields. The produced dual-polarization signatures of an X-band array radar for different scan scenarios are analyzed. [J43]

"Channel Modeling of Information Transmission Over Cognitive Interrogator-Sensor Networks"

This paper looks into the modeling of information transmission over cognitive interrogator-sensor networks (CISNs), which represent a novel and important class of sensor networks deployed for surveillance, tracking, and imaging applications. The crux of the problem is to develop a channel model that allows for the evaluation of the sensing channel capacity and error rate performance in CISNs, for which the sensing link is overlaid by the communication link. First, the layered discrete memoryless channel and finite-state Markov channel models are identified as useful tools to capture the essence of information transfer over the communication and sensing links in CISNs. Two different sensor encoding strategies, namely, 1) the amplify-modulate-and-forward (AMF) and 2) decode-modulate-and-forward (DMF) schemes, are considered. Subsequently, the concepts of double-directional channel capacity azimuth spectrum (CCAS) and Chernoff information azimuth spectrum (CIAS) are proposed to facilitate network-level assessment of the communication and sensing link reliability. A study case considering a typical CISN for environmental monitoring, conditioned on different wireless propagation and sensing conditions, is then presented to demonstrate the steps to derive the various model parameters. Finally, the potential applications of the proposed analytical framework in cognitive sensing, network performance assessment, and simulation are briefly discussed. [J44]

"An Improved Quality-Guided Phase-Unwrapping Algorithm Based on Priority Queue"

Phase unwrapping is one of the key problems in reconstructing the elevation map of a scene from interferometric synthetic aperture radar or interferometric synthetic aperture sonar (InSAS) data. In this letter, an improved quality-guided phase-unwrapping algorithm is proposed, which depends on the quality value and its surrounding quality information to guide the path of unwrapping more accurately. In order to design highly efficient quality-guided algorithm, a guided map deduced from the quality map is introduced and taken as the new quality map which the quality-guided algorithm should completely depend on. A quantized quality-guided method is designed, which adopts the quantized new quality map and the priority queue designed to optimize the process of unwrapping. The quantized quality map establishes the relation between the quality values and the indexes of array, which can save the time of inserting one pixel into the priority queue according to its integral quality value. Priority queue keeps all the pixels by their quantized quality in a nondecreasing order by maintaining the doubly linked lists in an increasing order. An optimized strategy is used to accelerate the process of finding the pixel with the highest quality value in the priority queue. Tests performed on real InSAS data and simulated interferograms confirm the accuracy and efficiency of the proposed algorithm, and the improved algorithm is suitable for our real-time processing InSAS system. [J45]

"DOMUS: DOppler MUltiple-Scattering Simulator"

Multiple scattering (MS) strongly affects CloudSat's W-band cloud-profiling radar (CPR) reflectivity when the satellite is overpassing moderate and heavy precipitation systems. With the upcoming deployment of W-band Doppler radars in space-Earth Clouds, Aerosols, and Radiation Explorer's CPR in primis-and the goal of retrieving vertical motions within convective systems, there is an urgent need to assess the impact of MS onto the Doppler signatures. A Monte Carlo code capable of simulating the reflectivity enhancement due to higher orders of scattering has been extended to include the Doppler effects. This paper presents the main guidelines for the inclusion of the Doppler analysis into the Monte Carlo scheme. To our knowledge, this simulator is the first one capable of simulating realistic Doppler signals in the presence of MS. The case studies are first presented in uniform beam-filling conditions for the profiles extracted from a cloud-resolving model simulation of deep convection (i.e., 1-D profiles are used to characterize a stratified atmosphere). The simulations demonstrate that, at ranges where MS contributions affect the overall radar signal, two main features appear as the following: 1) The Doppler spectrum tends to broaden with increasing MS enhancement, adding up to the single-scattering (SS) Doppler fading due to the satellite motion; and 2) the mean Doppler of the backscattered signal departs from the mean Doppler determined by the combined effect of the vertical-wind and hydrometeor-terminal velocities at all range bins below the altitude where the MS contribution significantly overcomes the SS. The simulator can be run in nonuniform-beam-filling conditions as well (i.e., a 3-D field is used to characterize the atmosphere at scales smaller than the radar resolution). With its cutting-edge capabilities, it provides a unique tool for the evaluation of the performances of the upcoming high-frequency spaceborne Doppler radars. [J46]

"Impact of Soil Structure on Microwave Volume Scattering Evaluated by a Two-Dimensional Numerical Model"

Soil volumetric structure is an important parameter for tillage operation. The aim of this paper is to assess whether volume characteristics can be inferred from radar measurements. A 2-D numerical model (the 2DSCAT model) was developed based on a numerical solver using a time-domain finite-element method to solve Maxwell's equations. Perfectly matched layers were implemented as well as a near- to far-field transformation. A focused incident beam was generated by adapting the boundary conditions. To represent the soil structure, a

simulator was developed describing the soil as biphasic media (fine earth and clods). Clods were represented by randomly deformed ellipses, with randomly determined dimensions, locations, and orientations. The model performed successfully, as evaluated against exact analytical solutions available for an infinite perfectly conducting cylinder and the reflection of flat semi-infinite media. The model was then evaluated against measurements made by an X-band FM continuous-wave radar on a box filled with dry clods of different sizes. The effect of the clod size on the backscattering power was very well reproduced, showing the potential of using a 2-D numerical model to understand microwave-backscattering patterns from cloddy soils. Analysis of the volume scattering shows that this phenomenon can be mostly hidden in the scatter diagram by surface scattering when the latter occurred. However, the volume scattering gives a stronger residual signal in time because of propagation through the medium. Thus, time studies of the scattering signal provide further information about volume heterogeneities. [J47]

"Validation of Microwave Tomographic Inverse Scattering Approach via Through-the-Wall Experiments in Semicontrolled Conditions"

This letter presents experimental verification of a tomographic through-the-wall radar imaging technique by exploiting real data measurements of 3-D scenes carried out under semicontrolled conditions. More specifically, the 3-D reconstructions are obtained by a linear inverse scattering algorithm and a sliced approach. This strategy ensures fast data processing and allows quick investigation of a very large spatial region. The effectiveness of the imaging scheme is shown for both a single-target scene and a scene with multiple targets at different depths. [J48]

"A New Improved Step Transform Algorithm for Highly Squint SAR Imaging"

In this letter, a new improved step transform (IST) algorithm is developed for highly squint stripmap synthetic aperture radar (SAR) imaging. Different from the previous step transform algorithms, such as the time-varying step transform algorithm, the new algorithm compensates the cubic phase term and the phase term caused by the varying chirp rate using estimation of the target position focused in the coarse-resolution fast Fourier transform, and these undesirable phase terms can be compensated more appropriately. The algorithm can process SAR imaging under a squint angle of up to 75° in X-band. Simulation results show that the IST algorithm is effective. [J49]

"Using Doppler Spectra to Separate Hydrometeor Populations and Analyze Ice Precipitation in Multilayered Mixed-Phase Clouds"

Multimodality of cloud radar Doppler spectra is used to partition cloud particle phases and separate distinct ice populations in the radar sample volume, thereby facilitating the analysis of individual ice showers in multilayered mixed-phase clouds. A 35-GHz cloud radar located at Barrow, Alaska, during the Mixed-Phase Arctic Cloud Experiment collected the Doppler spectra. Data from a pair of collocated depolarization lidars confirmed the presence of two liquid cloud layers reported in this letter. Both of these cloud layers were embedded in ice precipitation yet maintained their liquid. The spectral separation of the ice precipitation yielded two distinct ice populations: the ice initiated within the two liquid cloud layers and the ice precipitation formed in the higher cloud layers. The comparisons of ice fall velocity-versus-radar reflectivity relationships derived for distinct showers reveal that a single relationship does not properly represent the ice showers during this period. [J50]

"An Improved Scheme for Target Discrimination in High-Resolution SAR Images"

To design a highly automatic and practical method for target discrimination in synthetic aperture radar images, we propose in this paper an improved scheme consisting of the framework and algorithms for target discrimination. Our main contribution in this scheme comprises four aspects. First, an integrative frame sequentially combining the algorithm based on feature extraction and the knowledge of target group has been presented. Second, three new features for target discrimination have been introduced. Third, a genetic algorithm-based feature-selection algorithm has been presented. The results show that this algorithm can evaluate the goodness-of-feature better. Finally, to improve the accuracy of the discriminator, we have designed a weighted quadratic distance discriminator, which has been observed to improve the performance of target discrimination. We have analyzed the performance of the proposed scheme comprehensively and specifically using some measured data, and carried out comparisons of the existing algorithms. The results show that the proposed scheme could improve the application ability in target discrimination. [J51]

"A Sparse Aperture MIMO-SAR-Based UWB Imaging System for Concealed Weapon Detection"

A high-resolution imaging system based on the combination of ultrawideband (UWB) transmission, multiple-

input-multiple-output (MIMO) array, and synthetic aperture radar (SAR) is suggested and studied. Starting from the resolution requirements, spatial sampling criteria for nonmonochromatic waves are investigated. Exploring the decisive influence of the system's fractional bandwidth (instead of previously claimed aperture sparsity) on the imaging capabilities of sparse aperture arrays, a MIMO linear array is designed based on the principle of effective aperture. For the antenna array, an optimized UWB antenna is designed allowing for distortionless impulse radiation with more than 150% fractional bandwidth. By combining the digital beamforming in the MIMO array with the SAR in the orthogonal direction, a high-resolution 3-D volumetric imaging system with a significantly reduced number of antenna elements is proposed. The proposed imaging system is experimentally verified against the conventional 2-D SAR under different conditions, including a typical concealed-weapon-detection scenario. The imaging results confirm the correctness of the proposed system design and show a strong potential of the MIMO-SAR-based UWB system for security applications. [J52]

"Unsupervised Extraction of Flood-Induced Backscatter Changes in SAR Data Using Markov Image Modeling on Irregular Graphs"

The near real-time provision of precise information about flood dynamics from synthetic aperture radar (SAR) data is an essential task in disaster management. A novel tile-based parametric thresholding approach under the generalized Gaussian assumption is applied on normalized change index data to automatically solve the three-class change detection problem in large-size images with small class a priori probabilities. The thresholding result is used for the initialization of a hybrid Markov model which integrates scale-dependent and spatiocontextual information into the labeling process by combining hierarchical with noncausal Markov image modeling. Hierarchical maximum a posteriori (HMAP) estimation using the Markov chains in scale, originally developed on quadtrees, is adapted to hierarchical irregular graphs. To reduce the computational effort of the iterative optimization process that is related to noncausal Markov models, a Markov random field (MRF) approach is defined, which is applied on a restricted region of the lowest level of the graph, selected according to the HMAP labeling result. The experiments that were performed on a bitemporal TerraSAR-X StripMap data set from South West England during and after a large-scale flooding in 2007 confirm the effectiveness of the proposed change detection method and show an increased classification accuracy of the hybrid MRF model in comparison to the sole application of the HMAP estimation. Additionally, the impact of the graph structure and the chosen model parameters on the labeling result as well as on the performance is discussed. [J53]

"Focusing of Medium-Earth-Orbit SAR With Advanced Nonlinear Chirp Scaling Algorithm"

The signal processing of the medium-Earth-orbit synthetic aperture radar (SAR) is more challenging than that of the current low-Earth-orbit SAR because the imaging geometry is more complicated, and the range and azimuth variances are more severe. This paper deals with these imaging problems in three aspects. First, an advanced hyperbolic range equation (AHRE) is proposed for the first time, which is more precise for a spaceborne SAR than the conventional hyperbolic range equation (CHRE). Second, the point target spectrum based on the AHRE is analytically derived, which is useful for developing efficient SAR processing algorithms. Third, the well-known nonlinear chirp scaling (NLCS) algorithm is modified according to this new spectrum, and the so-called AHRE-based advanced NLCS (A-NLCS) algorithm is established. The simulation results validate the correctness of our method for L-band SAR systems at altitudes from 1000 to 10000 km with an azimuth resolution around 3 m. It is also shown that the A-NLCS algorithm has better performance than the CHRE-based algorithms in longer integration time cases. Therefore, we recommend the A-NLCS algorithm for a spaceborne SAR with a lower frequency, finer resolution, and higher satellite altitude. [J54]

"Edge Enhancement Algorithm Based on the Wavelet Transform for Automatic Edge Detection in SAR Images"

This paper presents a novel technique for automatic edge enhancement and detection in synthetic aperture radar (SAR) images. The characteristics of SAR images justify the importance of an edge enhancement step prior to edge detection. Therefore, this paper presents a robust and unsupervised edge enhancement algorithm based on a combination of wavelet coefficients at different scales. The performance of the method is first tested on simulated images. Then, in order to complete the automatic detection chain, among the different options for the decision stage, the use of geodesic active contour is proposed. The second part of this paper suggests the extraction of the coastline in SAR images as a particular case of edge detection. Hence, after highlighting its practical interest, the technique that is theoretically presented in the first part of this paper is applied to real scenarios. Finally, the chances of its operational capability are assessed. [J55]

"Combination of Advanced Inversion Techniques for an Accurate Target Localization via GPR for Demining Applications"

We used advanced ground-penetrating radar (GPR) inversion techniques for detecting landmines in laboratory conditions. The radar data were acquired with a calibrated vector network analyzer combined with an off-ground monostatic horn antenna, thereby setting up a stepped-frequency continuous-wave radar. Major antenna effects and interactions with the soil and targets were filtered out using frequency-dependent complex antenna transfer functions. The proposed strategy first exploits inversion approaches that are able to give an accurate characterization of the antenna-soil interaction and a reliable estimate of the soil permittivity. The outcomes of this first phase are at the basis of the application of a microwave tomographic approach based on the Born approximation to achieve the imaging of the subsurface. The algorithms were applied for imaging three landmines of different sizes and buried at different depths in sand. Although the radar system was off the ground, the results showed that it was possible to reconstruct all mines, including a shallow plastic mine as small as 5.6 cm in diameter. This last mine was invisible in the raw radar data, and the use of common GPR imaging techniques did not lead to satisfactory results. The proposed integrated method shows great promise for shallow subsurface imaging in a demining context, particularly because it automatically provides accurate information on the shallow soil dielectric permittivity. [J56]

"Electromagnetic Modeling of Breaking Waves at Low Grazing Angles With Adaptive Higher Order Hierarchical Legendre Basis Functions"

At low grazing angles (LGA), sophisticated electromagnetic scattering of sea surfaces may give rise to complicated surface-current distribution. Therefore, for the multilevel fast multipole algorithm (MLFMA) with the Rao-Wilton-Glisson basis function, the sea scatterer must be meshed fine enough to ensure the precision of the scattering at LGA, which brings huge computational costs. The higher order hierarchical Legendre vector basis functions can bring a great reduction of the unknowns and sparsification of the impedance matrix. The MLFMA with higher order hierarchical Legendre basis functions is applied in the electromagnetic-scattering approach of 3-D breaking water wave crests at LGA for the first time. In addition, an adaptive-order technique is also introduced for the first time in describing the currents which can achieve accurate results and maximally reduce the computational costs from some case analysis. It has been investigated in analyzing the vertically (VV) and horizontally (HH) polarized scattering of profiles of the LONGTANK breaking waves. "Sea-spike" phenomenon has been demonstrated at LGA. [J57]

"Fast Raw-Signal Simulation of Extended Scenes for Missile-Borne SAR With Constant Acceleration"

Fast raw-signal simulation is of considerable value for missile-borne synthetic aperture radar (SAR) algorithm development. On the basis of the two-dimensional (2-D) Fourier simulation method for stripmap SAR, we present a fast echo simulation method suitable for missile-borne SAR diving with constant acceleration. The analytical expression for the 2-D signal spectrum is derived and then converted to a stripmap one. Simulation results for a point target and a real scene demonstrate its validity and effectiveness. [J58]

"Robust Extraction of Urban Area Extents in HR and VHR SAR Images"

This work is devoted to analyze the performance and adapt the parameters requested for the operational use of a methodology aimed at urban extent extraction. The procedure, initially proposed in a reduced version in a previous paper, has been expanded and improved to make it useful with different HR and VHR radar sensors, and extensive comparison of the results in many different parts of the world have been considered. [J59]

"Seismic Source Quantitative Parameters Retrieval From InSAR Data and Neural Networks"

The basic idea of this paper relies on the concurrent exploitation of the capabilities of neural networks (NNs) and SAR interferometry (InSAR) for the characterization of a seismic source and the estimation of its geometric parameters. When a moderate-to-strong earthquake occurs, we can apply the InSAR technique to compute a differential interferogram. The earthquake is generated by an active seismogenic fault having its own specific geometry. The corresponding differential interferogram contains, in principle, information concerning the geometry of the seismic source that the earthquake comes from. To perform the inversion operation, a novel approach based on NNs is considered. This requires the generation of a statistically significant number of synthetic interferograms necessary for the network training phase. Each of them corresponds to a different combination of fault geometric parameters. After the training, the network is ready to perform, in real time, the inversion on new differential interferograms. This paper illustrates such a methodology and its validation on a set of experimental data. [J60]

"Ocean Wave Integral Parameter Measurements Using Envisat ASAR Wave Mode Data"

An empirical algorithm to retrieve integral ocean wave parameters such as significant wave height (SWH), mean wave period, and wave height of waves with period larger than 12 s (H12) from synthetic aperture radar (SAR) images over sea surface is presented. The algorithm is an extension to the Envisat Advanced SAR (ASAR) wave mode data based on the CWAVE approach developed for ERS-2 SAR wave mode data and is thus called CWAVE_ENV (CWAVE for Envisat). Calibrated ASAR images are used as the only source of input without needing prior information from an ocean wave model (WAM) as the standard algorithms used in weather centers. This algorithm makes SAR an independent instrument measuring integrated wave parameters like SWH and mean wave period to altimeter quality. A global data set of 25 000 pairs of ASAR wave mode images and collocated reanalysis WAM results from the European Centre for Medium-Range Weather Forecasts (ECMWF) is used to tune CWAVE_ENV model coefficients. Validation conducted by comparing the retrieved SWH to in situ buoy measurements shows a scatter index of 0.24 and 0.16 when compared to the ECMWF reanalysis WAM. Two case studies are presented to evaluate the performance of the CWAVE_ENV algorithm for high sea state. A North Atlantic storm during which SWH is above 18 m as observed by SAR and Radar Altimeter simultaneously is analyzed. For an extreme swell case that occurred in the Indian Ocean, the potential of using SWH measurements from ASAR wave mode data derived by the CWAVE_ENV algorithm is demonstrated. [J61]

"InSAR Deformation Time Series Using an -Norm Small-Baseline Approach"

Satellite synthetic aperture radar interferometry (InSAR) is an invaluable tool for land displacement monitoring. Improved access to time series of satellite data has led to the development of several innovative multitemporal algorithms. Small baseline (SB) is one such time-series InSAR method, based on combining and inverting a set of unwrapped interferograms for surface displacement. Two-dimensional unwrapping of sparse data sets is a challenging task, and unwrapping errors can lead to incorrectly estimated deformation time series. It is well known that L1-norm is more robust than L2-norm cost function minimization if the data set has a large number of outlying points. In this paper, we present an L1-norm-based SB method using an iteratively reweighted least squares algorithm. We show that the displacement phase of both synthetic data, as well as a real data set that covers the San Francisco Bay area, is recovered more accurately than with L2-norm solutions. [J62]

"Modeling PSInSAR Time Series Without Phase Unwrapping"

In this paper, we propose a least-squares-based method for multitemporal synthetic aperture radar interferometry that allows one to estimate deformations without the need of phase unwrapping. The method utilizes a series of multimaster wrapped differential interferograms with short baselines and focuses on arcs at which there are no phase ambiguities. An outlier detector is used to identify and remove the arcs with phase ambiguities, and a pseudoinverse of the variance-covariance matrix is used as the weight matrix of the correlated observations. The deformation rates at coherent points are estimated with a least squares model constrained by reference points. The proposed approach is verified with a set of simulated data. [J63]

"Classification of Tropical Vegetation Using Multifrequency Partial SAR Polarimetry"

This letter presents a case study addressing the comparison between different synthetic aperture radar (SAR) partial polarimetric options for tropical-vegetation cartography. These options include compact polarization (CP), dual polarization (DP), and alternating polarization (AP). They are all derived from fully polarimetric (FP) SAR data acquired by the airborne SAR (AIRSAR) sensor over the French Polynesian Tubuai Island. The classification approach is based on the support vector machine algorithm and is further validated by several ground surveys. For a single frequency band, FP data give significantly better results than any other partial polarimetric configuration. Among the partial polarimetric architectures, the CP mode performs best. In addition, the DP mode shows better performance than the AP mode, highlighting the value of the polarimetric differential phase. The combination of different frequency bands (P-, L-, and C-bands) holds the most significant improvement: The multifrequency diversity adds generally more information than the multipolarization diversity. A noticeable result is the major contribution of the C-band at VV polarization (the only polarization available at C-band with the AIRSAR data set used in this letter) to the classification performance, due to its ability to discriminate between Pinus and Falcata. [J64]

"Focusing of Tandem Bistatic-Configuration Data With Range Migration Algorithm"

A bistatic range migration algorithm (RMA) based on an exact analytical bistatic point-target (PT) spectrum in the tandem configuration is proposed in this letter. For the conventional geometry-based bistatic formula method, the derived spectrum is only a quasi-analytical one because a variable called half-quasi-bistatic angle (HQBA) is not exactly analytically expressed. The key step of the proposed algorithm is to deduce an analytical HQBA in the tandem configuration, and thus, an exact analytical closed-form PT spectrum is acquired. Based on this analytical spectrum, a bistatic RMA is presented. It is demonstrated that this algorithm can handle the bistatic

tandem configuration with extremely large baseline/range ratio and can also be applied to wide-swath imaging. [J65]

"The Effect of Orientation Angle Compensation on Coherency Matrix and Polarimetric Target Decompositions"

The polarization orientation angle (OA) of the scattering media affects the polarimetric radar signatures. This paper investigates the effects of orientation compensation on the coherency matrix and the scattering-model-based decompositions by Freeman-Durden and Yamaguchi et al. The Cloude and Pottier decomposition is excluded, because entropy, anisotropy, and alpha angle are roll invariant. We will show that, after orientation compensation, the volume scattering power is consistently decreased, while the double-bounce power has increased. The surface scattering power is relatively unchanged, and the helicity power is roll invariant. All of these characteristics can be explained by the compensation effect on the nine elements of the coherency matrix. In particular, after compensation, the real part of the (HH-VV) · HV* correlation reduces to zero, the intensity of cross-pol |HV| always reduces, and |HH-VV| always increases. This analysis also reveals that the common perception that OA compensation would make a reflection asymmetrical medium completely reflection symmetric is incorrect and that, contrary to the general perception, the four-component decomposition does not use the complete information of the coherency matrix. Only six quantities are included-one more than the Freeman-Durden decomposition, which explicitly assumes reflection symmetry. [J66]

"Design of Miniaturized Narrowband Absorbers Based on Resonant-Magnetic Inclusions"

In this paper, we present the design of miniaturized narrowband-microwave absorbers based on different kinds of magnetic inclusions. The operation of the proposed components originates from the resonance of a planar array of inclusions excited by an incoming wave with a given polarization. As in common absorber layouts, a 377 Ω resistive sheet is also used to absorb the electromagnetic energy of the impinging field. Since the planar array of magnetic inclusions behaves at its resonance as a perfect magnetic conductor, the resistive sheet is placed in close proximity of the resonating inclusions, without perturbing their resonance condition. In contrast to other typical absorber configurations presented in the literature, the absorber proposed in this paper is not backed by a metallic plate. This feature may be useful for stealth applications, as discussed thoroughly in the paper. The other interesting characteristic of the proposed absorbers is the subwavelength thickness, which has shown to depend only on the geometry of the basic resonant inclusions employed. At first, regular split-ring resonators (SSRs) disposed in an array configuration are considered and some application examples are presented. Absorbers based on SRRs are shown to reach thickness of the order of λ0/20. In order to further squeeze the electrical thickness of the absorbers, multiple SRRs and spiral resonators are also used. The employment of such inclusions leads to the design of extremely thin microwave absorbers, whose thickness may even be close to λ0/100. Finally, some examples of miniaturized absorbers suitable for a practical realization are proposed. [J67]

"A New Three-Dimensional Imaging Algorithm for Airborne Forward-Looking SAR"

In this letter, a new 3-D imaging algorithm is proposed for forward-looking synthetic aperture radar based on the imaging geometry and the characteristic of the echo signal. The key point of the proposed algorithm is the introduction of the nonlinear frequency modulation scaling in along-track processing to obtain accurate focusing. As the method needs only Fourier transform and multiplication operations, it is computationally efficient. Simulations with point scatterers are used to validate the method. [J68]

"Scattering and Doppler Spectral Analysis for Two-Dimensional Linear and Nonlinear Sea Surfaces"

Two-dimensional linear and second-order Creamer [Creamer (2)] nonlinear sea-surface models are combined with the second-order small-slope approximation method to comparatively study the electromagnetic scattering and the Doppler spectral characteristics from sea surfaces. Due to nonlinear hydrodynamics, the bistatic normalized radar cross section (NRCS) calculated from Creamer (2) surfaces is slightly larger than its linear surface counterpart for scattering angles departing from the specular direction, and the Creamer (2) surface backscattering coefficient increases as well for wind direction angles around upwind and downwind, whereas, for the crosswind direction, it is interesting to note that the observations are contrary. However, as was pointed out by Toporkov in a 1-D surface case, the effect of the nonlinear surface model on the average NRCS is minute. In particular, the Doppler spectra of the backscattered echoes are compared for the linear and Creamer (2) surfaces at various incident angles. It is seen, as expected, that the Doppler shifts and spectral widths of 2-D Creamer (2) surfaces exhibit different features compared with those of the linear surfaces, agreeing with the 1-D cases. However, for larger incident angles, the Doppler spectral broadening for Creamer (2) surfaces is not as

severe as was reported in previous 1-D studies that used full Creamer model. The reason for this discrepancy appears to be the reduced nature of the Creamer (2) approximation. Moreover, studies of the Doppler characteristics for different wind directions demonstrate that nonlinear effects become weaker as the wind direction varies from upwind to crosswind. [J69]

"Land Geophysical Parameters Retrieval Using the Interference Pattern GNSS-R Technique"

In the past years, the scientific community has placed a special interest in remotely sensing soil moisture and vegetation parameters. Radiometry and radar techniques have been widely used for years. Global Navigation Satellite Systems opportunity signals Reflected (GNSS-R) over the earth's surface are younger, but they have already shown their potential to perform these observations. This paper presents a GNSS-R technique, based on Global Positioning System (GPS) measurements, that allows the retrieval of several geophysical parameters from land surfaces. This technique measures the power of the interference signal between the direct GPS signal and the reflected one after scattering over the land, so it is called Interference Pattern Technique (IPT). This paper presents the results obtained after applying the IPT for topography, soil moisture, and vegetation height retrievals over vegetation-covered soils. [J70]

"SPEC Method-A Fine Coregistration Method for SAR Interferometry"

There is increasing demand for landscape acquisition using interferometric synthetic aperture radar for frequent Earth observation. Making an accurate digital elevation model (DEM) from an interferogram is often seriously affected by a mass of singular points (SPs) included in the interferogram. The origin of a type of SPs lies in inaccurate coregistration in making the interferogram. However, there have not been any method more effective than affine transformation based on cross correlation. Numerous research works have aimed at how to process the SPs resulting in the coregistration. In this paper, contrarily, we propose an additional method of local and nonlinear coregistration which employs the number of SPs as the evaluation criterion. This method provides us with an interferogram to generate a more accurate DEM. Experiments demonstrate that, with the proposed method, we can obtain a DEM having higher signal-to-noise ratios. [J71]

"Hybrid Core Acceleration of UWB SIRE Radar Signal Processing"

To move High-Performance Computing (HPC) closer to forward operating environments and missions, the Army Research Laboratory is developing approaches using hybrid, asymmetric core computing. By blending capabilities found in Graphics Processing Units (GPUs) and traditional von Neumann multicore Central Processing Units (CPUs), approaches are being developed and optimized to provide at or near real-time processing speeds for research project applications. Algorithms are designed to partition work to resources best designed to handle the processing load. The use of commodity resources allows the design to be flexible throughout the life cycle without the costly and time-consuming delays associated with Application-Specific Integrated Circuit (ASIC) development. This paradigm allows for rapid technology transfer to end users. In this paper, we describe a synchronous impulse reconstruction radar imaging algorithm that has been designed for hybrid CPU-GPU processing. We discuss various optimizations such as asynchronous task partitioning between the CPU and GPU as well as data movement reduction. We also discuss analysis and design of the algorithms within the context of two programming models: NVIDIA's CUDA and AMD's ATI Brook+. Finally, we report on the speedup achieved by this approach that allowed us to take a code once restricted to postprocessing and transform it into one that exceeds real-time performance requirements. [J72]

"Diagnosis of Induction Motor Faults in Time-Varying Conditions Using the Polynomial-Phase Transform of the Current"

Transient motor current signature analysis is a recently developed technique for motor diagnostics using speed transients. The whole speed range is used to create a unique stamp of each fault harmonic in the time-frequency plane. This greatly increases diagnostic reliability when compared with nontransient analysis, which is based on the detection of fault harmonics at a single speed. But this added functionality comes at a price: well-established signal analysis tools used in the permanent regime, mainly the Fourier transform, cannot be applied to the nonstationary currents of a speed transient. In this paper, a new method is proposed to fill this gap. By applying a polynomial-phase transform to the transient current, a new, stationary signal is generated. This signal contains information regarding the fault components along the different regimes covered by the transient, and can be analyzed using the Fourier transform. The polynomial-phase transform is used in radar, sonar, communications, and power systems fields, but this is the first time, to the best knowledge of the authors, that it has been applied to the diagnosis of induction motor faults. Experimental results obtained with two different commercial motors with broken bars are presented to validate the proposed method. [J73]

"Polarimetric Decomposition Over Glacier Ice Using Long-Wavelength Airborne PolSAR"

In recent years, there has been increased interest in using synthetic aperture radar (SAR) to study and monitor glaciers and ice sheets for glaciological and climate change research. However, due to the medium's complexity, SAR backscattering from ice remains poorly understood, including the relative importance of scattering from surface and volume layers and also dependences on frequency and glacier zone. Extreme weather conditions can result in quickly changing surface conditions influencing backscatter signatures while leaving the underlying volume of interest unchanged. Surface and volume components must thus be separated in order to infer information regarding the properties of the ice volume. This paper describes a three-component scattering model to decompose polarimetric SAR (PolSAR) images of glacier ice. Total backscatter is modeled as the incoherent summation of surface, volume, and sastrugi (wind-induced feature) components. The proposed model adapts and extends the Freeman and Durden decomposition for an ice volume scenario in which the volume is a dielectric medium. Forms of the model for both random and oriented volumes are considered, and a new oriented sastrugi component is introduced which is able to explain backscatter behavior between different winter scenes. Validation is performed with airborne PolSAR data at L- and P-band collected using the E-SAR system of the German Aerospace Center over the Austfonna ice cap in Svalbard, Norway, as part of the ICESAR campaign. [J74]

"The Glacier and Land Ice Surface Topography Interferometer: An Airborne Proof-of-Concept Demonstration of High-Precision Ka-Band Single-Pass Elevation Mapping"

As part of the NASA International Polar Year activities, a Ka-band cross-track interferometric synthetic aperture radar (SAR) recently demonstrated high-precision elevation swath mapping capability. This proof-of-concept instrument was achieved by interfacing two Ka-band slotted-waveguide antennas in a cross-track geometry and Ka-band electronics with the Jet Propulsion Laboratory's L-band uninhabited aerial vehicle SAR. Deployed on the NASA Gulfstream III, initial engineering flights in March and April 2009 marked the first airborne demonstration of single-pass cross-track interferometry at Ka-band. Results of a preliminary interferometric assessment indicate height precisions that, for a 3 m Ч 3 m posting, range from 30 cm in the near range to 3 m in the far range and greater than 5 km of swath over the urban areas imaged. The engineering flights were followed by a comprehensive campaign to Greenland in May 2009 for ice-surface topography mapping assessment. Toward that end, coordinated flights with the NASA Wallops Airborne Topographic Mapper lidar were conducted in addition to establishing ground calibration sites at both the Summit Station of the National Science Foundation and the Swiss Camp of the Cooperative Institute for Research in the Environmental Sciences. Comparisons of the radar-derived elevation measurements with both in situ and lidar data are planned for a subsequent paper; however, at this stage, a single data example over rugged ice cover produced a swath up to 7 km with the desired height precision as estimated from interferometric correlation data. While a systematic calibration, including assessment and modeling of biases, due to penetration of the electromagnetic waves into the snow cover has not yet been addressed, these initial results indicate that we will exceed our system requirements. [J75]

"Possibilistic Soil Roughness Identification for Uncertainty Reduction on SAR-Retrieved Soil Moisture"

Soil roughness plays an essential role in the reflection of the incoming radar signal at the soil surface and is, therefore, highly important in the retrieval of the soil moisture information from the backscattered radar signal. However, soil roughness, generally described by means of the root mean square (rms) height and the correlation length, remains difficult to measure correctly and is, furthermore, found to be highly variable. In order to overcome these difficulties, Verhoest et al. suggested the use of possibility distributions to reflect possible values of roughness parameters for a given roughness state of an agricultural field. These distributions were then further used to retrieve the soil moisture information. Nevertheless, as they estimated the possibility distributions by brute force, without taking into account any interactivity between the roughness parameters, rather wide distributions of retrieved soil moisture content were obtained. This paper first tries to independently estimate the possibility distributions for both roughness parameters on the basis of a synthetically generated roughness data set. Next, the interactivity between the rms height and the correlation length is taken into account through the identification of a joint possibility distribution by means of a possibilistic clustering algorithm. When applied to actual synthetic aperture radar data, the results show that a narrower, i.e., more specific, possibility distribution of the soil moisture content is obtained when the possibilistic retrieval procedure is performed based on the joint possibility distributions. [J76]

"A Gaussian Mixture Filter for Range-Only Tracking"

Range-only tracking problems arise in extended data collection for inverse synthetic radar applications, robotics,

navigation and other areas. For such problems, the conditional density of the state variable given the measurement history is multi-modal or exhibits curvature, even in seemingly benign scenarios. For this reason, the use of extended Kalman filter (EKF) and other nonlinear filtering techniques based on Gaussian approximations can result in inaccurate estimates. We introduce a new filter for such tracking problems in two dimensions called the Gaussian mixture range-only filter (GMROF), which generates Gaussian mixture approximations to the conditional densities. The filter equations are derived by analytic techniques based on the specific nonlinearities of range-only tracking. A slight modification of the standard measurement process model, "noise before nonlinearity," is used to simplify the moment calculations. Implementation requires, at each step, the fitting of a low order Gaussian mixture to a simple exponentiated trigonometric function of a scalar variable. Simulations involving scenarios from earlier comparative studies indicate that the GMROF consistently outperformed the EKF, and achieved the accuracy of particle filters while significantly reducing the computational cost. [J77]

"Backscatter 2- Lidar Validation for Atmospheric Differential Absorption Lidar Applications"

A 2-μm backscatter lidar system has been developed by utilizing tunable pulsed laser and infrared phototransistor for the transmitter and the receiver, respectively. To validate the system, the 2-μm atmospheric backscatter profiles were compared to profiles obtained at 1 and 0.5 μm using avalanche photodiode and photomultiplier tube, respectively. Consequently, a methodology is proposed to compare the performance of different lidar systems operating at different wavelengths through various detection technologies. The methodology is based on extracting the system equivalent detectivity and comparing it to that of the detectors, as well as the ideal background detectivity. Besides, the 2-μm system capability for atmospheric CO2temporal profiling using the differential absorption lidar (DIAL) technique was demonstrated. This was achieved by tuning the laser at slightly different wavelengths around the CO2R22 absorption line in the 2.05-μm band. CO2temporal profiles were also compared to in situ measurements. Preliminary results indicated average mixing ratios close to 390 ppm in the atmospheric boundary layer with 3.0% precision. The development of this system is an initial step for developing a high-resolution, high-precision direct-detection atmospheric CO2DIAL system. A successful development of this system would be a valuable tool in obtaining and validating global atmospheric CO2measurements. [J78]

"Exploration of Subsidence Estimation by Persistent Scatterer InSAR on Time Series of High Resolution TerraSAR-X Images"

Ground subsidence is a major concern for land use planning and engineering risk assessment. This paper explores subsidence detection by the persistent scatterer (PS) interferometric synthetic aperture radar (InSAR) technique using the multitemporal high resolution spaceborne SAR images. We first describe the mathematical models and the data reduction procedures of the PS solution. The experiments of subsidence detection are then carried out over the Jinghai County in Tianjin (China) which has been sinking due to overuse of groundwater. The time series of high resolution SAR images collected by the X-band radar sensor onboard the satellite TerraSAR-X (TSX) are utilized for the PS detection, PS networking and subsidence estimation. The experimental results demonstrate that the high resolution of TSX SAR images can dramatically increase the PSs' density and coverage extent, especially in the built-up areas. Subsidence values can be extracted on the individual objects like buildings, street lamps and manhole covers, and on the linear engineering structures like the Jinghu high-speed railway. The PS InSAR with short radar wavelength (3.1 cm) is quite sensitive to ground displacement in the radar line-of-sight direction, and the derived subsidence measurements are in good agreement with the in situ data taken by optical leveling. [J79]

"Approaches for Compression of Super-Resolution WSR-88D Data"

Weather radar products from the U.S. National Weather Service (NWS) are used by the government and private sectors. Very high resolution radar data are increasingly being utilized in real time. However, the bandwidth needed to transmit these data (termed level-II super-resolution data) from the radar to the destination site is a limiting issue. General-purpose compression programs are not tuned to the properties of weather radar data. As the NWS continues to upgrade the capabilities of radar network, the amount of data will continue to increase. As a result, compression is of vital interest to keep down maintenance, storage, and transmission costs. A method for lossless compression of these data on a radial-by-radial basis focusing on the delta (difference) between range bins of super-resolution radar data is presented and is called super-resolution delta compression (SRDC). There are several specialized aspects of SRDC that are based on the properties of weather radar data. SRDC was tested on level-II reflectivity product data from several S-band Doppler weather radars in the NWS network and was compared with two general-purpose compression programs and a different weather-radar-specific compression approach. The results show that the newly developed SRDC yield is approximately 17% better than the next best approach and approximately 47% better than only preprocessed radials. [J80]

"A Cluster-Analysis-Based Efficient Multibaseline Phase-Unwrapping Algorithm"

Multibaseline phase unwrapping is a critical processing procedure of multibaseline synthetic aperture radar interferometry (InSAR). It has an advantage over single-baseline phase unwrapping in discontinuous-terrain-height estimation. In this paper, the pixels' combination information of multiple InSAR interferograms with different baseline lengths is deeply investigated, and the term ambiguity vector is proposed to represent a pixel's ambiguity number of multiple interferograms. It is also revealed that pixels with the same ambiguity vector have an exclusive pattern among them. A fast cluster-analysis (CA)-based method is proposed for multibaseline phase unwrapping. In this method, all pixels are first clustered into different groups according to their patterns, and then, information of the cluster center is used to unwrap the phases of pixels group by group. Simulation results are shown to verify the effectiveness, efficiency, and noise robustness of CA multibaseline phase-unwrapping method. [J81]

"Multifunctional Software-Defined Radar Sensor and Data Communication System"

Orthogonal frequency-division multiplexing (OFDM) signal coding and system architecture were implemented to achieve radar and data communication functionalities. The resultant system is a software-defined unit, which can be used for range measurements, radar imaging, and data communications. Range reconstructions were performed for ranges up to 4 m using trihedral corner reflectors with approximately 203 m of radar cross section at the carrier frequency; range resolution of approximately 0.3 m was demonstrated. Synthetic aperture radar (SAR) image of a single corner reflector was obtained; SAR signal processing specific to OFDM signals is presented. Data communication tests were performed in radar setup, where the signal was reflected by the same target and decoded as communication data; bit error rate of was achieved at 57 Mb/s. The system shows good promise as a multifunctional software-defined sensor which can be used in radar sensor networks. [J82]

"Application of a Simple Adaptive Estimator for an Atmospheric Doppler Radar"

A simple method for estimating parameters of the Doppler spectrum of atmospheric signals is described. The method is based on an adaptive filter processing that has been widely used in telecommunications but rarely applied in measurements using atmospheric radars. The method has been tested using both synthetic and real data obtained by the radar profiler-Transportable Atmospheric Radar (TARA)-and the weather radar-International Research Centre for Telecommunications and Radar (IRCTR) Drizzle Radar (IDRA)-both developed by IRCTR. The method is compared with the traditional pulse-pair method and fast Fourier transform (FFT)-based methods, as well as with the IRCTR FFT-based method implemented in the TARA and IDRA processing including an additional noise clipping stage. The tests have demonstrated high efficiency of the adaptive filtering estimator under low signal-to-noise ratio conditions. The applicability of adaptive estimations in radar meteorology and the limitations associated with a sample length are discussed. [J83]

"Exploiting MIMO SAR Potentialities With Efficient Cross-Track Constellation Configurations for Improved Range Resolution"

In this paper, an innovative technique is presented for synthetic aperture radar (SAR) ground range resolution improvement using multiple transmit and receive platforms with adequate cross-track displacement. Using orthogonal waveforms, which occupy the same bandwidth in the range frequency domain, for the different platforms of the constellation, a multiple-input-multiple-output SAR system is configured. The proposed technique allows one to achieve a maximum theoretical range resolution improvement factor that is significantly greater than the number of operating SAR sensors by jointly exploiting both mono- and bistatic acquisitions. This can be exploited to obtain a ground range resolution that is much higher than the resolution corresponding to the frequency bandwidth transmitted by the single platform. After illustrating the proposed technique and its system requirements, a simulated data set is used to show the effectiveness of the proposed approach. [J84]

"Ground Moving Targets Imaging Algorithm for Synthetic Aperture Radar"

It is well known that the motion of a target induces range migration, especially for high-resolution synthetic aperture radar (SAR) systems. Ground moving target imaging necessitates the correction of the unknown range migration. To finely refocus a moving target, one must accurately obtain the motion parameters for compensating the target trajectory. However, in practice, these parameters usually cannot be precisely estimated. This paper proposes a new imaging approach for ground moving targets without a priori knowledge of their motion parameters. In the devised method, the azimuth compression function is constructed in range frequency domain, which can eliminate the coupling effect between range and azimuth. Theoretical analysis confirms that the methodology can precisely focus targets without interpolation procedure. The effectiveness of the proposed imaging technique is demonstrated by both simulated and real airborne SAR data. [J85]

"Building Detection From One Orthophoto and High-Resolution InSAR Data Using Conditional Random Fields"

Today's airborne SAR sensors provide geometric resolution in the order well below half a meter. Many features of urban objects become visible in such data. However, layover and occlusion issues inevitably arise in urban areas complicating automated object detection. In order to support interpretation, SAR data may be analyzed using complementary information from maps or optical imagery. In this paper, an approach for building detection in urban areas based on object features extracted from high-resolution interferometric SAR (InSAR) data and one orthophoto is presented. Features describing local evidence as well as context information are used. Buildings are detected by classification of those feature vectors within a Conditional Random Field (CRF) framework. Although as graphical model similar to Markov Random Fields (MRF), CRFs have the advantage of incorporating global context information, of relaxing the conditional independence assumption between features, and of a more general integration of observations. We show that, first, CRFs perform well in comparison to Maximum Likelihood classifiers and MRFs. Second, the combined use of optical and InSAR features may improve detection results. [J86]

"Physical Limitations on Detecting Tunnels Using Underground-Focusing Spotlight Synthetic Aperture Radar"

This paper examines the feasibility of underground-focusing spotlight synthetic aperture radar (UF-SL-SAR) systems for tunnel detection applications. A general formulation is reviewed for generating UF-SL-SAR imaging by using multiple frequencies across a wide band and by focusing in space to subsurface points using well-known ray refraction at the nominal ground surface. A full-wave finite-difference frequency-domain model is used to consider wave propagation in realistic soil with loss- and frequency-dependent dielectric constant and a randomly rough ground surface, both of which serve to obscure and distort the returned tunnel target signal. Imaging results are presented for two representative soil scenarios: dry sand and moist clay loam. Considering the ground surface ray refraction for focusing greatly improves the SAR image relative to conventional SAR focusing at the ground surface. Using UF-SL-SAR, a small shallow tunnel is reasonably imaged for the sand case, despite the roughness of the ground interface. However, for higher conductivity moist clay loam, the clutter from the rough surface overwhelms the significantly attenuated target signal, which must propagate through the lossy intervening soil. It is demonstrated that, despite ideal focusing, the tunnel is successfully imaged only for the sand case. [J87]

"Multiregion Image Segmentation by Parametric Kernel Graph Cuts"

The purpose of this study is to investigate multiregion graph cut image partitioning via kernel mapping of the image data. The image data is transformed implicitly by a kernel function so that the piecewise constant model of the graph cut formulation becomes applicable. The objective function contains an original data term to evaluate the deviation of the transformed data, within each segmentation region, from the piecewise constant model, and a smoothness, boundary preserving regularization term. The method affords an effective alternative to complex modeling of the original image data while taking advantage of the computational benefits of graph cuts. Using a common kernel function, energy minimization typically consists of iterating image partitioning by graph cut iterations and evaluations of region parameters via fixed point computation. A quantitative and comparative performance assessment is carried out over a large number of experiments using synthetic grey level data as well as natural images from the Berkeley database. The effectiveness of the method is also demonstrated through a set of experiments with real images of a variety of types such as medical, synthetic aperture radar, and motion maps. [J88]

"Coherence, Polarization, and Statistical Independence in Cloude-Pottier's Radar Polarimetry"

The Cloude-Pottier radar polarimetry paradigm, which is understood as the spectral decomposition theorem of the target coherency matrix plus the classification technique based on the triad of parameters given by entropy, alpha angle, and anisotropy, has become a very well-established methodology for treating high-resolution polarimetric radar images, particularly those obtained with synthetic aperture radar (SAR) sensors. This methodology is revisited here from the standpoint of the coherence and polarization theory and their mutual relationship, in the light of the interest aroused once again after Wolf's article on this subject in 2003. Despite its success in terms of acceptance by the SAR community, the Cloude-Pottier paradigm relies on the arguable assumption that different scattering mechanisms can be separated by diagonalizing the aforementioned coherency matrix and then assigning each corresponding eigenvector to one of the independent scattering mechanisms. Our main statement in this paper is that the coherency matrix illustrates the behavior of the target from the point of view of polarization and not of full coherence, which would justify this assumption, even if only partially. Therefore, it is not rigorous to identify each eigenvector of this decomposition with a distinct scattering

mechanism. Cloude and Pottier argue that the eigendecomposition of the coherency matrix outperforms other target decomposition theorems due to its uniqueness. It is also suggested that this very uniqueness, together with the orthogonality of the eigenvectors, supports the injective mapping between scattering mechanisms and eigenvectors that was first assumed based on statistical independence. With the aim of providing a comprehensive overview of the problem, we discuss some important concepts with regard to both field and target coherency matrices. In addition, we revise the concepts of entropy, alpha angle, and anisotropy as defined by the aforementioned authors, which are-- also a central part of this paradigm and which have played an important role in SAR image classification since its introduction. Again, some disagreement is found with the meaning of these parameters as they have been discussed so far. [J89]

"Three-Dimensional SAR Focusing From Multipass Signals Using Compressive Sampling"

Three-dimensional synthetic aperture radar (SAR) image formation provides the scene reflectivity estimation along azimuth, range, and elevation coordinates. It is based on multipass SAR data obtained usually by nonuniformly spaced acquisition orbits. A common 3-D SAR focusing approach is Fourier-based SAR tomography, but this technique brings about image quality problems because of the low number of acquisitions and their not regular spacing. Moreover, attained resolution in elevation is limited by the overall acquisitions baseline extent. In this paper, a novel 3-D SAR data imaging based on Compressive Sampling theory is presented. It is shown that since the image to be focused has usually a sparse representation along the elevation direction (i.e., only few scatterers with different elevation are present in the same range-azimuth resolution cell), it suffices to have a small number of measurements to construct the 3-D image. Furthermore, the method allows super-resolution imaging, overcoming the limitation imposed by the overall baseline span. Tomographic imaging is performed by solving an optimization problem which enforces sparsity through ℓ1-norm minimization. Numerical results on simulated and real data validate the method and have been compared with the truncated singular value decomposition technique. [J90]

"An adaptive filtering algorithm for blind waveform estimation in diffuse multipath channels"

The use of spatial filtering is considered to isolate a single propagation mode of an unknown narrowband signal received as a superposition of multipath components by a sensor array for the purpose of source waveform estimation. In the problem addressed, multipath propagation from source to receiver occur due to diffuse scattering from a number of distinct but extended regions of an irregular medium rather than ideal specular reflection. The combined presence of diffuse scattering and array calibration uncertainties may cause the spatial signatures of the incident distributed signal modes to deviate significantly from the plane-wave array manifold. Furthermore, the temporal signature of the waveform to be recovered may also be quite arbitrary, with no known deterministic or statistical properties that can be utilised for multipath separation. The lack of knowledge regarding the propagation channel, array manifold and source waveform poses a major challenge for the task at hand. This study proposes a new blind spatial filtering technique, referred to as the generalised estimation of multipath signals (GEMS) algorithm, which can effectively separate distributed signal modes for accurate source waveform estimation. This algorithm actually exploits the presence of multipath propagation and wavefront distortions as the basis for signal separation. The performance of GEMS is compared with two benchmark signal-copy procedures using real data from an experimental finite impulse response single-input multiple-output high frequency (HF) system. [J91]

"Performance of knowledge aided space time adaptive processing"

In this study, the asymptotic average signal-to-interference plus noise ratio (SINR) loss of knowledge-aided (KA) space time adaptive processing (STAP) is derived based on the random matrix theory. The authors observe that the desired steering vector and a priori covariance matrix is whitened by the covariance matrix of cell under test. An important result in this study is that one finds the SINR loss of KA STAP can be factorised into two parts. The first part of SINR loss is determined by the number of independent and identically distributed secondary samples, system degree of freedom, colour loading level and the eigenvalues of whitened a priori covariance matrix. The angle between two vectors accounts for the second part of SINR loss, where the first vector is the whitened desired steering vector, the second vector is a rotated version of this whitened vector with the rotation matrix equal to whitened a priori covariance matrix. Several cases including both accurate a priori knowledge and inaccurate a priori knowledge as the colour loading matrix are studied. Performance loss because of inaccurate a priori knowledge is analysed. Numerical simulations are conducted to validate the authors theoretical analysis, shows that the results based on random matrix theory fit the empirical results by Monte-Carlo trials well. [J92]

"Unambiguous doppler centroid estimation approach for synthetic aperture radar data based upon compressed signal magnitude"

A new approach to Doppler ambiguity resolution is presented. This approach adopts the fact that the absolute Doppler centroid is a linear function of range frequency. Based on this concept, an alternative azimuth compression method that is without a prior knowledge about the motion parameters is developed and carried out in range frequency domain to accumulate the target energy along the azimuth. The resulting trajectories become straight lines with the same slope proportional to the unwrapped Doppler centroid. This slope can be well estimated by the azimuth cell walk correction/integration method. Two sets of measured synthetic aperture radar data (airborne and spaceborne radar) show that this approach works well in medium- and high-contrast scenes. [J93]

"Taylor series expansions for airborne radar space-time adaptive processing"

Space-time adaptive processing (STAP) for range-dependent clutter rejection in airborne radar is considered. Indeed, radar antenna architectures or configurations that are different from the conventional uniform linear antenna array (ULA) and side-looking (SL) configuration have consequences on the clutter properties. The authors here investigate the use of Taylor series expansions (TSEs) of the space-time covariance matrix in the classical sample matrix inversion (SMI) STAP method in order to mitigate the range non-stationarity of the clutter and they compare it to the derivative-based updating (DBU) already proposed in the literature. The authors also propose a new algorithm based on a TSE of the clutter plus noise subspace in conjunction with the eigencanceler-based (EC) STAP, which improves the performance in term of signal-to-interference plus noise ratio (SINR) loss, compared to the DBU method. In this study, the particular cases of a ULA and a uniform circularly curved antenna (UCCA) array in SL and non-SL monostatic configurations as well as a ULA in some bistatic configurations are considered for the test and the comparison of the presented algorithms. [J94]

"Strategy of doppler centroid estimation in synthetic aperture radar"

Doppler centroid is an important parameter in synthetic aperture radar (SAR) image processing. Owing to measurement uncertainties, many clutter-lock algorithms are proposed to estimate the Doppler centroid. One of the factors that affect the estimation is `chirp coupling` [linear FM signal is used as transmitting signal in SAR, and this makes echoes of targets from different range bins overlap with each other at the same range bin, which could be called `chirp coupling (CHCO)`]. In broadside or lowly squint mode SAR, CHCO is often ignored. However, with large squint angle, its influence on Doppler centroid estimation will increase and even affect the final image. The azimuth-frequency shift of echoes caused by CHCO is analysed and a method proposed to calculate the threshold angle which is used to judge its influence on Doppler centroid estimation. With the help of the threshold angle, a novel strategy of Doppler centroid estimation is proposed. After theoretic analyses, simulations and experimental results are provided to demonstrate the proposed strategy of Doppler centroid estimation. [J95]

"Range autofocus for linearly frequency-modulated continuous wave radar"

A software-based method for estimating and compensating for chirp non-linearity in frequency-modulated continuous wave radars is described. The method is based on the phase-gradient algorithm and time-domain warping of the dechirped signal. The method is demonstrated both on typically and severely non-linear chirps. The retrospective application is demonstrated on archive radar data. [J96]

"Exact analytical two-dimensional spectrum for bistatic synthetic aperture radar in tandem configuration"

An exact analytical solution for the two-dimensional (2-D) point target spectrum is usually difficult to obtain because of the existence of a double-square-root (DSR) term in the bistatic range equation. Some approximate solutions for the 2-D spectrum have been derived and used in order to focus bistatic synthetic aperture data. A geometry-based bistatic formula (GBF) method was used for obtaining a quasi-analytical form of a bistatic 2-D spectrum by Zhang (2007). Although the GBF method cannot completely solve the problem of the DSR term, it provides a novel aspect for dealing with this problem. In this study, based on the quasi-analytical spectrum, the authors change the signal expression space and transform the eight-order polynomial equation in terms of the slow time into the four-order polynomial equation in terms of the half quasi-bistatic angle (HQBA) for the tandem configuration. Then the DSR-term problem is successfully solved and a corresponding exact analytical bistatic 2-D spectrum is obtained. It is proved that the spectra acquired by Rocca's smile operator, Loffeld's bistatic formula (LBF) and the method of series reversion (MSR) are equivalent to this proposed analytical spectrum when certain conditions are met, and that this exact analytical spectrum is the most accurate among them. [J97]

"A Signal Level Simulator for Multistatic and Netted Radar Systems"

Efficient analysis of modern multistatic and netted radar systems requires a new generation of dedicated radar

simulation software. Key requirements for such software are simulation accuracy and flexibility in choosing system parameters. In this paper, algorithms for the simulation of raw radar return signals are presented based on interpolation and modification of the transmitted signal and modelling of the radar hardware and environment. This method supports simulation of pulsed and CW systems; monostatic, multistatic, and netted systems; phased-array radars; and most physically realizable radar system configurations. [J98]

"New Parameter Estimation and Detection Algorithm for High Speed Small Target"

Target detection and parameter estimation are the principal problems of radar applications. The detection and parameter estimation for high-speed small targets are challenging for narrowband radar since the target may only occupy one range cell with small reflectivity. In addition, the high speed makes the target shift through range cells during the observation period, which makes it difficult to improve the target's reflecting energy coherent accumulation and signal-to-noise ratio (SNR). An algorithm for high-speed small target detection and parameter estimation with narrowband radar is proposed in this paper. Firstly three target motion parameters, i.e., the cross-range frequency modulation rate, ambiguous Doppler frequency, and fold factor are estimated one by one. Then based on the estimated parameters, a target detection method is proposed. In addition, we also analyze the detection performance under estimation error. After that, an improved method for fold factor estimation is presented. Simulation results have proved the validity of the proposed algorithm. [J99]

"Geometry-Induced Range-Dependence Compensation for Bistatic STAP with Conformal Arrays"

Radar space-time adaptive processing (STAP) is a well-suited technique to detect slow-moving targets in the presence of a strong interference background. We consider STAP for a radar operating in a bistatic radar configuration and collecting returns with a conformal antenna array (CAA). The statistics of the secondary data snapshots used to estimate the optimum weight vector are not identically distributed with respect to range, thus preventing the STAP processor from achieving its optimum performance. The compensation of the range-dependence (RD) requires the knowledge of the locus of the clutter signature. We use a new RANSAC-based method for estimating this locus or, equivalently, the flight configuration parameters. Based on this knowledge, we perform an RD compensation of the snapshots to obtain an accurate estimate of the clutter covariance matrix. End-to-end performance analysis in terms of signal-to-inference-plus-noise ratio loss shows that our method yields promising performance. [J100]

"Sandglass transformation for synthetic aperture radar detection and imaging of ship at low signal-to-clutter-plus-noise ratio"

Space/air-borne synthetic aperture radar (SAR) detection and imaging of moving ships at sea are important for ocean reconnaissance and fishery monitoring. A novel algorithm based on sandglass transformation to detect weak ships and form high-quality images under the conditions of low signal-to-clutter-plus-noise ratio is presented here. It requires no prior information about motion parameters of targets. The sandglass transformation can decouple the time and lag time in the instantaneous autocorrelation function of a linear frequency modulated (LFM) signal. Thus the cross-range signals of ship in the approximate form of LFM signals can be integrated coherently via the two-dimensional fast Fourier transformation. The proposed algorithm can not only achieve high-energy accumulation gain, but also suppress the interference of cross terms effectively without loss of resolution. Hence, it is effective to detect weak ships and generate high-resolution images. Numerical and experimental results confirm the effectiveness of the proposed algorithm. [J101]

"Robust, Reduced Rank, Loaded Reiterative Median Cascaded Canceller"

A robust, fast-converging, reduced-rank adaptive processor called the loaded reiterative median cascaded canceller (LRMCC) is introduced. The LRMCC exhibits the highly desirable combination of 1) convergence-robustness to outliers/targets/nonstationary data in adaptive weight training data, and 2) fast convergence at a rate commensurate with reduced-rank algorithms. Simulated jamming data as well as measured airborne radar data from the MCARM space-time adaptive processing (STAP) database are used to show performance enhancements. Performance is compared with the fast maximum likelihood (FML) and sample matrix inversion (SMI) algorithms. It is demonstrated that the LRMCC is easily implemented and is a highly robust replacement for existing reduced-rank adaptive processors, exhibiting superior performance in nonideal measured data environments. [J102]

"Performance Analysis of Two-Dimensional Parametric STAP for Airborne Radar using KASSPER Data"

We analyze the performance of a recently introduced class of two-dimensional (2-D) multivariate parametric

models for space-time adaptive processing (STAP) in airborne radars on the DARPA airborne side-looking radar model known as KASSPER Dataset 1. Investigation of the impact of linear uniform antenna array errors on techniques that exploit spatial smoothing is demonstrated using a complementary phenomenological clutter model developed at the AFRL. Signal-to-interference-plus-noise ratio (SINR) degradation with respect to the optimal clairvoyant receiver is studied for different parametric models, antenna errors, and training sample volumes. We also analyze the impact of KASSPER training data inhomogeneity on STAP performance. For an extremely small number of training-data samples, we demonstrate that a properly selected parametric model and an accompanying covariance matrix estimation technique should achieve efficient performance for practical STAP applications. [J103]

"Ionosphere-corrected range estimation in dual frequency global navigation satellite systems receivers"

In global navigation satellite systems (GNSSs), the measurement of the satellite-receiver pseudorange requires the estimation of signal's delay. Because the accuracy of the latter affects significantly the accuracy of the final position, it is essential to consider the effect of various error sources. Ionosphere is commonly regarded as one of the most influential sources because of the fact that it can significantly delay the signal; therefore it is of paramount importance to mitigate its effects. In theory, a dual-frequency receiver can virtually eliminate the ionospheric effects if higher order effects are ignored. Although such an advantage has been widely recognised in the literature, the effect of the tracking error in the ionospheric correction and inherently on the range estimation is yet to be studied. In this study, the authors investigate the effect of tracking error on the ionosphere-corrected range in dual-frequency receivers and compare the performance of the traditional approach with least square (LS) and constrained LS methods, as well as with a new method for range estimation, proposed by the authors. The results showed that the traditional and LS methods perform well only under the restriction of zero tracking error, whereas the authors' method has the best average performance. [J104]

"Road Intensity Based Mapping Using Radar Measurements With a Probability Hypothesis Density Filter"

Mapping stationary objects is essential for autonomous vehicles and many autonomous functions in vehicles. In this contribution the probability hypothesis density (PHD) filter framework is applied to automotive imagery sensor data for constructing such a map, where the main advantages are that it avoids the detection, the data association and the track handling problems in conventional multiple-target tracking, and that it gives a parsimonious representation of the map in contrast to grid based methods. Two original contributions address the inherent complexity issues of the algorithm: First, a data clustering algorithm is suggested to group the components of the PHD into different clusters, which structures the description of the prior and considerably improves the measurement update in the PHD filter. Second, a merging step is proposed to simplify the map representation in the PHD filter. The algorithm is applied to multi-sensor radar data collected on public roads, and the resulting map is shown to well describe the environment as a human perceives it. [J105]

"Sparsity-Based Multi-Target Tracking Using OFDM Radar"

We propose a sparsity-based approach to track multiple targets in a region of interest using an orthogonal-frequency-division multiplexing (OFDM) radar. We observe that in a particular pulse interval the targets lie at a few points on the delay-Doppler plane and hence we exploit that inherent sparsity to develop a tracking procedure. The use of an OFDM signal not only increases the frequency diversity of our system, as different scattering centers of a target resonate variably at different frequencies, but also decreases the block-coherence measure of the equivalent sparse measurement model. In the tracking filter, we exploit this block-sparsity property in developing a block version of the compressive sampling matching pursuit (CoSaMP) algorithm. We present numerical examples to show the performance of our sparsity-based tracking approach and compare it with a particle filter (PF) based tracking procedure. The sparsity-based tracking algorithm takes much less computational time and provides equivalent and sometimes better, tracking performance than the PF-based tracking. [J106]

"Electromagnetic Land Surface Classification Through Integration of Optical and Radar Remote Sensing Data"

We present a nonhierarchical electromagnetic (EM) land surface classification method through the integration of satellite multispectral high-resolution optical and polarized radar images of central Alberta near the Saskatchewan border. We implement a conventional supervised land surface classification method and a principal component analysis to a QuickBird image. The EM properties are then assigned to the classified

surfaces to produce hierarchical EM land classification maps. To further classify a hierarchical EM surface (i.e., dielectric constant), we calculate the root-mean-square surface height with a Shuttle Radar Topography Mission 3-arc-second digital elevation model and the temperatures from a thermal band of a Landsat-5 Thematic Mapper image. We also calculate the backscattering coefficients from the Advanced Land Observing Satellite Phased Array L-band Synthetic Aperture Radar image. Using these estimated values, we calculate the intrinsic weighting factors with the Dubois (1995) model for less vegetated land areas and the Ulaby (1986) model for open water areas. By applying these weighting factors to the hierarchical EM surface, we generate a nonhierarchical higher resolution EM surface map of the study area. [J107]

"Foreword to the Special Issue on the 2009 International Geoscience and Remote Sensing Symposium (IGARSS '09)"

The nine papers in this special issue were originally presented at the 2009 International Geoscience and Remote Sensing Symposium (IGARSS '09), held at the University of Cape Town, Rondebosch, South Africa, from July 12 to 17. [J108]

"Through-Wall Opportunistic Sensing System Utilizing a Low-Cost Flat-Panel Array"

A UWB through-wall imaging system is proposed based on a planar low profile aperture array operating from 0.9 GHz to 2.3 GHz. The goal is to provide a lightweight, fixed array to serve as an alternative to synthetic aperture radars (SAR) that require continuous array movement while collecting data. The proposed system consists of 12 dual-linear printed elements arranged within a triangular lattice, each forming a "flower" shape and backed by a ground plane. The array delivers half-space radiation with wideband performance, necessary for imaging applications. UWB capability is realized by suppressing grating lobes via the introduction of virtual phase centers interwoven within the actual array feeds. The proposed system is demonstrated for through-wall imaging via a non-coherent process. Distinctively, several coherent images are forged from various fixed aperture locations (referred to as "snapshot" locations) and appropriately combined to create a composite scene image. In addition to providing a unique wideband imaging capability (as an alternative to SAR), the system is portable and inexpensive for collecting/storing scattering data. The array design and data collection system is described, and several through-wall images are presented to demonstrate functionality. [J109]

"Group Object Structure and State Estimation With Evolving Networks and Monte Carlo Methods"

This paper proposes a technique for motion estimation of groups of targets based on evolving graph networks. The main novelty over alternative group tracking techniques stems from learning the network structure for the groups. Each node of the graph corresponds to a target within the group. The uncertainty of the group structure is estimated jointly with the group target states. New group structure evolving models are proposed for automatic graph structure initialization, incorporation of new nodes, unexisting nodes removal, and the edge update. Both the state and the graph structure are updated based on range and bearing measurements. This evolving graph model is propagated combined with a sequential Monte Carlo framework able to cope with measurement origin uncertainty. The effectiveness of the proposed approach is illustrated over scenarios for group motion estimation in urban environments. Results with challenging scenarios with merging, splitting, and crossing of groups are presented with high estimation accuracy. The performance of the algorithm is also evaluated and shown on real ground moving target indicator (GMTI) radar data and in the presence of data origin uncertainty. [J110]

"Adaptive HF interference cancellation for sky wave over-the-horizon radar"

A computationally efficient adaptive beamforming algorithm for high-frequency (HF) sky wave over-the-horizon radar to suppress the spatially nonstationary HF interference while preserving the temporal coherence of the clutter echoes is proposed. The proposed algorithm is based on the generalised sidelobe canceller structure with constraint on the time-varying weight vectors. Experimental data-processing results show the effectiveness of the algorithm. [J111]

"Fast method for multi-target localisation in bistatic MIMO radar"

A computationally efficient method for multi-target localisation in bistatic MIMO radar is presented. The key idea is to apply the propagator method which requires only linear operation but does not involve any eigendecomposition of the sample covariance matrix. Compared with the ESPRIT method, it has lower computational complexity and gives better performance, particularly when the ratio of the product of transmitter and receiver array size to the number of targets is large. Simulation results are presented to verify the effectiveness of the proposed method. [J112]

"Cross-correlation performance assessment of global positioning system (GPS) L1 and L2 civil codes for signal acquisition"

Owing to imminent availability of global positioning system (GPS) L2C full constellation, low-cost dual-frequency GPS L1/L2C receivers are likely to appear on the market in the near future. The L1 C/A, L2 CM and L2 CL are the code choices available to combat the `near-far` problem in such a receiver. The published average cross-correlation protection figures of these codes (C/A: 22 dB, CM: 28 dB and CL: 45 dB) are not sufficient to determine the right code choice for different acquisition scenarios. The aim of this study is to evaluate the robustness of each code to the near`far problem and develop recommendations for code/frequency selection in a given acquisition scenario. For comparison of L2C and C/A codes, multiple C/A periods are to be considered, in order to be consistent with the signal observation interval. It is shown that the cross-correlation performance of multiple C/A periods is strongly dependent on the relative Doppler offset between local and interfering signals, and consequently it is much superior to that of the single C/A period. It is concluded that the C/A code is more robust to the near`far problem in the assisted acquisition scenarios including warm start, hot start, assisted-GPS and reacquisition, whereas L2 CM is the best code choice for the cold startup. [J113]

"Signal fusion-based target detection algorithm for spatial diversity radar"

Signal fusion-based radar target detection algorithms are studied in this article for spatial diversity multiple input multiple output (MIMO) radar based on the generalised likelihood ratio test (GLRT) algorithm, under the assumption that covariance matrices of clutter signals received by different radar sites are different. Two signal fusion-based target detection algorithms are proposed, which can be applied in signal fusion networks (SFNs) with typical structures, at a low communication and computation cost. Simulation experiments in several scenarios indicate that two proposed signal fusion algorithms have better detection performances than decision fusion algorithms. [J114]

"Innovation Rate Sampling of Pulse Streams With Application to Ultrasound Imaging"

Signals comprised of a stream of short pulses appear in many applications including bioimaging and radar. The recent finite rate of innovation framework, has paved the way to low rate sampling of such pulses by noticing that only a small number of parameters per unit time are needed to fully describe these signals. Unfortunately, for high rates of innovation, existing sampling schemes are numerically unstable. In this paper we propose a general sampling approach which leads to stable recovery even in the presence of many pulses. We begin by deriving a condition on the sampling kernel which allows perfect reconstruction of periodic streams from the minimal number of samples. We then design a compactly supported class of filters, satisfying this condition. The periodic solution is extended to finite and infinite streams and is shown to be numerically stable even for a large number of pulses. High noise robustness is also demonstrated when the delays are sufficiently separated. Finally, we process ultrasound imaging data using our techniques and show that substantial rate reduction with respect to traditional ultrasound sampling schemes can be achieved. [J115]

"MIKON 2010-18 th International Conference on Microwaves, Radar and Wireless Communications [JConference Report]"

{no data available} [J116]

"Broadband waveguide slot array for SAR"

A new kind of wideband waveguide slot array for synthetic aperture radar (SAR) is presented. Elliptical slots are first used for designing the waveguide slot antenna. An eight-element waveguide slot array operating at X-band is designed and measured. Predicted results are compared with measured data and good agreement is reported. The measured bandwidth for VSWR ≤ 1.5 has reached 19.6%. [J117]

"MVDR Beamforming for Through-the-Wall Radar Imaging"

We present high-definition imaging for targets behind walls and enclosed structures based on constrained minimization RF multisensor processing. Minimum variance distortionless response (MVDR) beamforming is used on both sensor-frequency raw data radar returns and spatial spectrum data, which is obtained by the Fourier transform of the delay and sum beamformer image. We compare both methods for near-field and far-field scenes. The paper considers both cases of known and unknown wall parameters and uses manifold constraints to allow target localization in high-definition imaging in the presence of wall errors. Also, through analyses and simulations, we show how to effectively use the spatial spectrum to improve covariance matrix estimation and subsequently enhance image quality in the sense of lower sidelobes. [J118]

"FDGLRT detector of MIMO radar in non-homogeneous clutter"

Recently, an adaptive generalised likelihood ratio test-linear quadratic (AGLRT_LQ) detector has been proposed for MIMO radar in the presence of non-homogeneous clutter. However, this method suffers a large performance loss when the amount of secondary data available is small. In this reported work, a full data GLRT detector is derived by utilising not only the primary data but also the secondary data in the design process and the covariance matrix estimation process to decrease this loss. [J119]

"Mapping Soil Moisture Using RADARSAT-2 Data and Local Autocorrelation Statistics"

The purpose of this study is to evaluate the capability of surface radar backscatter models to estimate soil moisture over agricultural fields from fully polarimetric RADARSAT-2 C-band synthetic aperture radar (SAR) responses. For validation purposes, ground measurements over 44 sampling sites in eastern Ontario, Canada were carried out in the spring of 2008 simultaneously with satellite data acquisitions. Soil moisture retrieval was accomplished using two semi-empirical scattering models (Dubois and Oh) and the SAR image backscatter. Discrepancies between measured radar backscatter coefficients and those predicted by the models were previously reported, requiring correction factors to reduce biases associated with these semi-empirical approaches. Soil moisture was estimated by explicitly solving the two backscatter equations of the Dubois model, and using a look-up table (LUT) approach applied to the Oh model. Results showed that the Oh model in a cross-polarization (HH-HV) and Dubois in a co-polarization (HH-VV) inversion scheme provide the best estimates. These model configurations were implemented to produce multi-date soil moisture maps for the eastern Ontario site. To expand the range of validity of these soil moisture estimates, the maps produced by the Dubois and Oh models were uniquely combined. These estimates of absolute soil moisture were then used to derive spatial patterns of near-surface moisture content using the Getis statistic. The Getis statistic maps provide meaningful spatial information, demonstrating the potential of combining the Getis statistic and RADARSAT-2 data in predicting soil moisture conditions. [J120]

"Direction of arrival estimation using virtual array search"

This study explores the application of the advanced array interpolation technique for direction of arrival estimation. It uses an array of Global Positioning System (GPS) sonobuoys, as a method for enhancing the bearing estimation accuracy, improving target tracking capabilities. Currently, the bearing estimation of underwater targets using sonobuoys is based on fusion of bearings, obtained through individual element processing. This preserves the advantage of having a widely spread field of sonobuoys to detect underwater targets. However, the low levels of signal-to-noise ratio (SNR) jeopardise the bearing estimation accuracy. This can be improved using array processing of a directional frequency analysis and recording (DIFAR) sonobuoy field. The environmental conditions and deployment strategies impose limitations on the array processing of a DIFAR sonobuoy field. These factors mainly cause the array of sonobuoys to be a non-uniform sparse array. Advanced array interpolation is proposed to mitigate the current processing limitations degrading the system performance. This method is tested using acoustic level simulation. Simulation results show that the proposed method improves the processing of nonuniform sparse arrays based on the SNR and the inter-element distances of the array. [J121]

"Using radar echo to confront anti-radiation missiles"

A new method using radar echo to confront anti-radiation missiles (ARMs) is presented. Phase difference is obtained through radar echo by using the `2 loop phase difference measurement` algorithm. Coherent decoys are generated by phase difference obtained for confronting ARMs. The predicted results are presented to verify the effectiveness of this method. [J122]

"Working as an R&D Engineer in the Los Angeles Aerospace Industry [JMTT World]"

Los Angeles, arguably the heart of the aerospace industry in the United States, has long been one of the central hubs for the U.S. microwave industry. The microwave industry in Southern California primarily focuses on providing radar and communications payloads for aerospace systems. Large defense and aerospace corporations are supported by a host of small and medium companies and are also supported by a network of excellent universities, including the University of California at Los Angeles, the California Institute of Technology and the University of Southern California. [J123]

"Estimating the parameters of sinusoids and decaying sinusoids in noise"

Picture a low earth orbit satellite hurtling around the earth in an 800 km orbit. At this altitude, the satellite travels about 7.5 km every second, and any signals between it and an earth terminal experience significant Doppler

shifts. These frequency offsets must be estimated and removed at the earth terminal to enable successful communications with the satellite. As in this example, the estimation of the parameters of a sinusoid plays a fundamental role in a variety of applications ranging from seismology to radar and biological signals. Therefore, this problem has received, and continues to receive, significant attention in the literature. In power delivery systems, the estimation of the supply frequency is required for the monitoring of the system quality and the detection of faults [1], [2]. In nuclear magnetic resonance spectroscopy (NMRS), on the other hand, the signal is modelled as a sum of decaying complex exponentials whose frequencies and decay factors must be estimated [3]. [J124]

"Ground-based radar interferometer for tracking fast approaching targets"

This study describes the design and initial evaluation of a radar that detects and tracks a fast approaching target in a short-range application. In some radar applications, tracking durations less than 1 s and 3D tracking accuracy of a few tens of centimetres are required. To satisfy these requirements, a radar interferometer is proposed to simultaneously detect and track a target. A frequency-modulated continuous wave (FMCW) waveform is chosen and a method of separating clutter from a valid signal is developed to obtain very precise range information. In the tracking algorithm, a least squares (LS) filter is adopted because of its fast computing speed and good convergence characteristics to a steady state. This system is constructed using an open architecture approach, with a direct digital synthesiser, a field programmable gate array (FPGA) and a digital signal processor (DSP) as core components. The radar system was evaluated through real field testing. The test results showed that the proposed radar and tracking methods are able to estimate very accurate target positions in real field testing. [J125]

"Analysis of wide-angle radar imaging"

In wideband radar imaging, it is necessary to increase the target observation angle, that is, the imaging time to obtain high azimuth resolution. For wide-angle targets, however, migration through resolution cell will occur and the Doppler information of the scatterers will be time varying, which can lead to image defocusing in both the range and azimuth domain if the range??Doppler (RD) method is applied. Aimed at this problem, this study builds up the imaging model for steadily moving targets with a constant rotation axis. Then it compares the RD algorithm, the Keystone algorithm and the polar format algorithm with theoretical analysis and deduces the maximum observation angles that fit for these methods, respectively. Additionally, this study proposes a new algorithm for imaging of targets with large observation angles based on the complex inverse Radon transform. Instead of applying the Taylor??s series approximation, this method strictly follows the signal model for scatterers with a wide observation angle and utilises curvilinear integral with phase information for image formation. Therefore it is valid in wide-angle scenarios. Finally, imaging results for both the simulated and measured data are given to analyse the performance of the available algorithms and to prove the validity of the proposed algorithm. [J126]

"Improved ambiguity estimation using a modified fractional radon transform"

Ambiguity estimation is critical for the positioning of a moving target truly. Traditional real-value Radon transform (RRT) has been used to estimate the slope of target??s trajectory such that the ambiguity number can be derived. However, the unknown azimuth velocity of the target makes it difficult to determine the ambiguity number because the quadratic range cell migration (QRCM) caused by the platform velocity reduces the sensitivity of the RRT in the estimation. Also, the RRT does not work well when the signal-to-noise ratio (SNR) is low. Here, a method that uses the second-order Keystone transform (SOKT) to eliminate the QRCM and the modified fractional Radon transform (MFrRT) to estimate the ambiguity number was proposed. The method was simple and applicable in the low-SNR situation. Implementation considerations were presented. Finally, the effectiveness of the method has been shown using simulated and acquired synthetic aperture radar datasets. [J127]

"Automatic modulation classification of radar signals using the generalised time-frequency representation of Zhao, Atlas and Marks"

The automatic modulation classification (AMC) of a detected radar signal is a challenging task of an electronic intelligence (ELINT) receiver in a non-cooperative environment. With the aim to realise the AMC of five kinds of radar signals under negative signal-to-noise ratio (SNR), the authors have gained four characteristic features, namely, the ratio of sum of absolute slope, the coefficient of polynomial curve fitting, the number of ridge stairs and the normalised coefficient of difference of the extreme, from the generalised time-frequency representation of Zhao, Atlas and Marks (ZAM-GTFR). Simulation results show the probabilities of successful recognition (PSRs) can reach 90% when SNR is above 22 dB. The algorithm is suitable for the ELINT receiver when the

detection range is critical. [J128]

"Radio frequency interference cancellation for sea-state remote sensing by high-frequency radar"

High-frequency surface wave radar (HFSWR) has been widely adopted as a useful remote-sensing tool for sea-state monitoring. There are limitations to the performance because of various unwanted clutters and interferences that contaminate radar signals. Among all types of unwanted signals, radio frequency interference (RFI) is dominant since the frequency bands 3??30 MHz, the operation range of HFSWR, are shared by many radio services. If RFI occupies the areas in the Doppler spectrum that are essential for the estimation of oceanographic parameters, for example, wind speed, current speed, wave height etc., it will significantly reduce the quality of the data. The characteristics of RFI in time, space and Doppler domains are analysed for sea-state monitoring, and a robust and general signal processing method consisting of image recognition, segmentation processing and subspace projection for cancellation of RFI is proposed. The effectiveness of this approach is validated using data obtained with the Pisces HF radar, which is a high-performance radar developed for long-range wave measurement, operating in the lower half of the HF band (5??10 MHz). [J129]

"Application of clutter reduction techniques for detection of metallic and low dielectric target behind the brick wall by stepped frequency continuous wave radar in ultra-wideband range"

A study of clutter reduction techniques for detection of metallic and non-metallic (low dielectric constant) targets behind a brick wall with the help of ultra-wideband (UWB) through wall imaging system is presented. It is known that sometimes the clutter level is comparable to the level of target reflection that makes it difficult to detect the target correctly. Detection of low dielectric constant materials becomes more difficult due to low reflection from such targets. Therefore there is a need to analyse various clutter removal techniques and check the performance of these techniques for enhancement of target signal-to-clutter ratio. For this purpose, an UWB stepped frequency wave radar is indigenously assembled with the use of vector network analyser, which works in the frequency range of 3.95??5.85 GHz. An experiment is carried out for detection of metal as well as Teflon (low dielectric constant) targets with the application of clutter reduction techniques. The authors have considered statistical-based techniques like singular value decomposition, principle component analysis, factor analysis and independent component analysis (ICA) for clutter removal. It is observed that the signal-to-clutter ratio for metal target detection is quite enhanced by all the four techniques, whereas only ICA is able to enhance the signal-to-clutter ratio for a low dielectric constant target like Teflon. [J130]

"Adaptive clutter suppression and resolving of velocity ambiguities for an experimental three-channel airborne synthetic aperture radar-ground moving target indication system"

This study investigates practical processing methods aiming at detecting ground moving targets and estimating their motion parameters for an experimental three-channel airborne synthetic aperture radar-ground moving target indication (SARGMTI) system. It focuses on two key points of GMTI processing: adaptive clutter suppression and resolving of velocity ambiguities. Different from the conventional clutter suppression based on SAR images or in range-Doppler domain of the entire-aperture pulses, the clutter cancellation is proposed to be performed in the Doppler domain of short-aperture pulses to avoid the superposition of clutter echoes from different ground patches in azimuth; meanwhile, the ground moving target signals are focused with the full aperture to maximise the signal-to-noise ratio. To resolve the velocity ambiguity, a joint strategy is proposed that combines the estimates of the along-track interferometric phases and the Doppler spectrum information of a ground moving target according to the Chinese remainder theorem. The implementations of the processing operations are verified with real data from the experimental three-channel airborne SAR-GMTI system. [J131]

"Monopulse comparator with frequency-independent delta-channel nulls for high-resolution tracking radar"

A novel super-broadband planar monopulse comparator is presented, and demonstrated experimentally. This comparator is based on a recently discovered 180° hybrid coupler derived from the conventional Wilkinson divider. Because of its symmetric configuration, the proposed comparator exhibits frequency-independent nulls at its three difference output ports and therefore features a quasi unlimited bandwidth. This property substantially enhances the overall broadband resolution performance of monopulse comparators with direct benefits in tracking radar applications. [J132]

"Detection of Ships in Marine Environments by Square Integration Mode and Multilayer Perceptrons"

A novel method for detecting ships in marine environments is presented in this paper. For this purpose, the

information contained in the marine images obtained by a measuring and monitoring marine system is used. The ship detection is done by multilayer perceptrons (MLPs). In the first approach, the MLP processes the information extracted from the images using horizontal or vertical integration modes. However, if a suitable combination of these integration modes is done, better detection performances are achieved. Therefore, the use of an improved integration mode is proposed, which is based on a square shape. These modes are also used in a commonly used detector, the cell averaging constant false alarm rate (CA-CFAR) detector, which is taken as reference in our experiments. The comparison of the performances of both detectors shows how the MLP-based detector outperforms the CA-CFAR detector in all the cases under study. This comparison is based on objective (probabilities of false alarm and detection) and subjective estimations of their performances. The MLP-based detector also presents another advantage, particularly when the square integration mode is considered: high-performance robustness against changes in the marine environmental conditions. [J133]

"Locating a weak change using diffuse waves: Theoretical approach and inversion procedure"

We describe a time-resolved monitoring technique for heterogeneous media. Our approach is based on the spatial variations of the cross-coherence of diffuse waves acquired at fixed positions but at different dates. The technique applies to all kind of waves, provided that waveforms can be acquired with a sampling frequency much larger than the wave frequency. To locate and characterize a weak change that occurred between successive acquisitions, we use a maximum likelihood approach combined with a diffusive propagation model. We characterize this technique, locating a weak change using diffuse waves, called LOCADIFF, with the aid of numerical simulations. In several illustrative examples, we show that the change can be located with a precision of a few wavelengths and that its effective scattering cross-section can be retrieved. We investigate how the accuracy and precision of the method depends on the number of source-receiver pairs, on the time window used to compute the cross-correlation and on the errors in the propagation model. Applications can be found in nondestructive testing, seismology, radar, and sonar location. [J134]

"Surface acoustic wave devices as passive buried sensors"

Surface acoustic wave (SAW) devices are currently used as passive remote-controlled sensors for measuring various physical quantities through a wireless link. Among the two main classes of designs-resonator and delay line-the former has the advantage of providing narrow-band spectrum informations and hence appears compatible with an interrogation strategy complying with Industry-Scientific-Medical regulations in radio-frequency (rf) bands centered around 434, 866, or 915 MHz. Delay-line based sensors require larger bandwidths as they consists of a few interdigitated electrodes excited by short rf pulses with large instantaneous energy and short response delays but is compatible with existing equipment such as ground penetrating radar (GPR). We here demonstrate the measurement of temperature using the two configurations, particularly for long term monitoring using sensors buried in soil. Although we have demonstrated long term stability and robustness of packaged resonators and signal to noise ratio compatible with the expected application, the interrogation range (maximum 80 cm) is insufficient for most geology or geophysical purposes. We then focus on the use of delay lines, as the corresponding interrogation method is similar to the one used by GPR which allows for rf penetration distances ranging from a few meters to tens of meters and which operates in the lower rf range, depending on soil water content, permittivity, and conductivity. Assuming propagation losses in a pure dielectric medium with negligible conductivity (snow or ice), an interrogation distance of about 40 m is predicted, which overcomes the observed limits met when using interrogation methods specifically developed for wireless SAW sensors, and could partly comply with the above-mentioned applications. Although quite optimistic, this estimate is consistent with the signal to noise ratio observed during an experimental demonstration of the interrogation of a delay line buried at a-- depth of 5 m in snow. [J135]

"Range-Spread Target Detection using Consecutive HRRPs"

In this paper, a heuristic detector is proposed to detect range-spread targets in white Gaussian noise using multiple consecutive high- resolution range profiles (HRRPs) received from a high-resolution radar (HRR). The detector consists of refiners of HRRPs and a cross-correlation integrator of refined HRRPs. Based on the fact that strong scattering cells are sparse in target HRRPs, nonlinear shrinkage maps are designed to refine received HRRPs before integration, by which most of the noise-only cells in received HRRPs are suppressed while strong scattering cells most probably relevant to target signature are preserved. Since the target's scattering geometry is almost unchanged except for range walking during integration, the refined target HRRPs from consecutive pulses are highly similar while refined noise-only HRRPs are dissimilar due to randomicity. The modified correlation matrix of multiple refined HRRPs is used to measure their similarity. The test statistic, a weighted integration of the entries of the modified correlation matrix, is constructed for target detection. The proposed detector does not depend on a strict target return model and can work in mild conditions. The real target data and simulated noise are used to evaluate the detector, and the experimental results show that it

achieves better detection performance than some existing methods. [J136]

"D/A conversion networks for high-resolution SAR A/D converters"

An intermittent-sleeping C-R hybrid structure and a resistor-reusing R-C hybrid structure are presented for high-resolution SAR A/D converters. The switching power of these conversion networks and the matching requirements of their internal passive components are researched based on high-level Matlab modelling. Their applicability to high-resolution SAR ADCs is proven by realisation of two SAR A/D converters with these two novel D/A networks. [J137]

"Measurement of Radar Spurious Emission With High Dynamic Range and Optimized Measurement Time"

The purpose of this paper is to propose and analyze a novel field-capable method for measuring the spurious emission levels of weather radar. The method consists of time- and frequency-domain measurements. The time-domain measurements determine radar parameters, such as pulse duration, duty cycle, pulse repetition rate, and antenna rotation time; these are then used in the frequency-domain sweep measurements to obtain the relative level of radar spurious emissions in a given bandwidth with a minimum measurement time for a given average percentage of measured bandwidth. A large dynamic range (≥100 dB) is obtained by using a calibrated bandstop (BS) filter for controlled attenuation of the pulse spectrum at the nominal frequency. Results are shown for commercial weather radar at 5 GHz. This paper shows the need for radar signal filtering to prevent interference with other radio systems, such as radio local access network (RLAN) worldwide interoperability for microwave access (WiMAX), ultrawideband (UWB), and terrestrial radio relay systems, particularly those operating just above or below the nominal frequency of radar. The results give important information for radar system planning and communication network operations. [J138]

"Using EMD-FrFT Filtering to Mitigate Very High Power Interference in Chirp Tracking Radars"

This letter presents a new signal processing subsystem for conventional monopulse tracking radars that offers an improved solution to the problem of dealing with manmade high power interference (jamming). It is based on the hybrid use of empirical mode decomposition (EMD) and fractional Fourier transform (FrFT). EMD-FrFT filtering is carried out for complex noisy radar chirp signals to decrease the signal's noisy components. An improvement in the signal-to-noise ratio (SNR) of up to 18 dB for different target SNRs is achieved using the proposed EMD-FrFT algorithm. [J139]

"Simultaneous radar frequency/electro-optical tracking and characterisation of dismounts"

This study discusses the fusion of radar frequency (RF) data and electro-optical (EO) data for tracking and characterisation of dismounts (i.e. humans). Each of these sensor modalities provides unique information about the location, structure and movement of a dismount. The person's location is tracked on the 2D ground plane using RF data for range measurements and EO data for angle measurements. Using this information, measurements are made on the structure and dynamic motion (gait) of the person. An imaging approach is used to create spatio-temporal activity maps along with a three-dimensional reconstruction of the dismount. [J140]

"Rao and wald tests design of polarimetric multiple-input multiple-output radar in compound-gaussian clutter"

In high-resolution radars or at low gazing angles, the clutter is more satisfied in the compound-Gaussian model. Meanwhile, the polarisation diversity can be exploited to enhance the detection performance. Motivated by extending the detection problem of multiple-input multiple-output radar to such cases, this study mainly addresses the adaptive detectors design with an unknown covariance matrix based on Rao and Wald criterions. The two-step design strategy is adopted. Three estimation strategies of covariance with secondary data, such as sampled covariance matrix (SCM), normalised sampled covariance matrix (NSCM) and fixed point estimation (FPE) matrix, are introduced to make derived receivers fully adaptive. A thorough performance assessment is given by several numerical examples, the results of which show that Rao and Wald tests can provide good detection performance in even spikier clutter, and the polarimetric diversity can also be exploited to improve the detection performance. Meanwhile, the FPE strategy is more suitable to implement the adaptive detection algorithms, and the adaptive loss is completely acceptable in practical applications. [J141]

"Change detection in SAR images by means of grouping connected regions using clone selection algorithm"

Most of the change detection techniques for SAR images based on the analysis of the difference image always

generate the result map at the pixel level, which leads to a noisy change detection map, with holes in connected components and jagged boundaries. To attack this problem, a novel technique to generate the result at the region level is proposed, which considers each connected region as an agent and then gives the optimal label combination for all agents through the clone selection algorithm and a new fitness function. The region oriented method can avoid the above problem and improve the change detection performance. Experimental results on the real Radarsat SAR dataset validate the effectiveness of the method on both the quantitative and subjective aspects. [J142]

"Remote Sensing of Volcanic Ash Cloud During Explosive Eruptions Using Ground-Based Weather RADAR Data Processing [JIn the Spotlight]"

The ash ejected into the atmosphere by the Eyjafjalla Icelandic volcano during its recent eruption posed such a threat to flights over much of Europe that the ensuing cancellations resulted in an unprecedented disruption of the European commercial air transportation system. Volcanic ash is not only a significant hazard to aircraft operations but also to public safety from volcanic ash fall at the surface. Given the significance of the hazards posed by volcanic ash, timely detection and tracking of the erupted ash cloud is essential to a successful warning process, particularly during and immediately following an eruptive event. In this article, we will discuss ground-based radar (radio detection and ranging) data processing for ash cloud remote sensing pointing to the physical basis of retrieval algorithms and an example of their application. [J143]

"Low-complexity ESPRIT-based DOA estimation for colocated MIMO radar using reduced-dimension transformation"

Direction of arrival (DOA) estimation for colocated multiple-input multiple-output (MIMO) radar is considered. An estimation of signal parameters via rotational invariance techniques (ESPRIT)-based DOA estimation for the MIMO radar using reduced-dimension transformation is proposed to reduce the complexity. The proposed algorithm has very close angle estimation performance to conventional ESPRIT; also it has slightly better performance than conventional ESPRIT for low SNR. Simulation results verify the usefulness of the proposed algorithm. [J144]

"Improved bilateral filtering for SAR image despeckling"

To effectively preserve edges of synthetic aperture radar (SAR) images while cleanly despeckling, an improved bilateral filtering algorithm (IBF) is proposed. A threshold value is first calculated, which is used to distinguish whether the current pixel and its neighbouring pixels are homogeneous or not. Then, bilateral filtering (BF) is improved by reducing its two parameters to one, which emphasises the contribution of adjacent homogeneous pixels to the approximation of the current pixel. Finally, IBF is applied to remove speckles. The despeckling results for SAR images show that the visual quality and evaluation indexes of IBF outperform those of enhanced Lee filtering (ELF) and BF. [J145]

"Enhanced monopulse tracking radar using optimum fractional Fourier transform"

Conventional monopulse radar processors are used to track a target that appears in the look direction beam width. The distortion produced when additional targets appear in the look direction beam width can cause severe erroneous outcomes from the monopulse processor. This leads to errors in the target tracking angles that may cause target mistracking. A new signal processing algorithm is presented in this study which offers a solution to this problem. The technique is based on the use of optimal fractional Fourier transform (FrFT) filtering. The relative performance of the new filtering method over traditional-based methods is assessed using standard deviation angle estimation error (STDAE) for a range of simulated environments. The proposed system configuration succeeds in significantly cancelling additional target signals appearing in the look direction beam width even if these targets have the same Doppler frequency. [J146]

"Target localisation for distributed multiple-input multiple-output radar and its performance analysis"

This study considers the problem of target localisation with a coherent processing technique for distributed multiple-input multiple-output radar systems. To enable the coherent processing technique, dual-frequency transmitters are employed to eliminate the stochastic phases of complex fading coefficients, which are caused by target angular fluctuations. And then a two-step procedure is introduced to accomplish the target localisation. In the first step, the amplitudes of the complex fading coefficients are estimated. In the second step, the target position is obtained using the MUSIC algorithm with modified target steering vector. With the amplitudes estimated, the target localisation performance is improved. The Cramer-Rao bound (CRB) for target localisation accuracy is derived with precise knowledge of radar positions. The CRB is shown to be inversely proportional to

the frequency difference between the transmitted signals. With the radar positions uncertainty, the average asymptotic performance of the proposed method is given. Finally, numerical examples are given to validate the proposed method and the theoretical analyses. [J147]

"Target detection in high-resolution sea clutter via block-adaptive clutter suppression"

Attentions have been focused on the moving target detection in a high-resolution sea clutter. This study commences with a proposal of median-based estimator to estimate the power spectrum of high-resolution sea clutter by the time series observed in adjacent range cells and time intervals. The estimator provides a robust estimation when just a few aberrant time series happen in observation. Based on the estimator, a block-adaptive clutter suppression filter (BACSF) is designed to suppress the clutter prior to the pulse integration. Then, the residual clutter, the output of the BACSF, is modelled as spherically invariant random vector. Upon applying an adaptive normalised matched filter (ANMF) to the residual clutter, a residual clutter's ANMF detector is derived. Moreover, in high-resolution radar background, considering that the approximately stationary intervals of sea clutter and residual clutter are much shorter than the coherent processing interval, another heuristic block-ANMF detector is proposed. It can integrate more pulses and can achieve better performance than the ANMF detector does. This study concludes with the experiments of simulated target against the real sea clutter. The experimental results demonstrate that, when target's Doppler frequency is beyond strong clutter region, the ANMF detector and block-ANMF detector perform better in the residual clutter than in the clutter. [J148]

"Combining pyramid representation and AdaBoost for urban scene classification using high-resolution synthetic aperture radar images"

This study presents a new algorithm called pyramid representation (PR)-AdaBoost, which combines PR and AdaBoost for urban area classification using high-resolution synthetic aperture radar (SAR) images. PR is used to hierarchically represent local feature sets and AdaBoost is used to choose proper features from the PR vector and effectively discriminate categories. The authors evaluate the proposed algorithm on a data set consisting of high-resolution SAR images of five different categories of scene and on a real TerraSAR-X image. The experimental results have shown that PR-AdaBoost can achieve higher classification accuracy than AdaBoost based on global representation or local representation such as bag-of-features. It also outperforms classical classifiers such as nearest neighbour, boosted distance and support vector machine based on the same representation. [J149]

"Active sample-selecting and manifold learning-based relevance feedback method for synthetic aperture radar image retrieval"

Content-based image retrieval (CBIR) provides an effective way to address the increasing need for intelligent data access to synthetic aperture radar (SAR) image repositories. In CBIR, a critical component is relevance feedback (RF), which is used to bridge the `semantic gap`. This study proposes a new RF method with active sample-selecting and manifold learning for CBIR of SAR images. In this method, the authors adopt a modified maximum margin projection with a new neighbourhood estimation criterion to discover both the geometrical structure and discriminant structure of the underlying data manifold. In order to achieve a satisfactory performance with limited feedback samples, the authors also propose an active sample selection strategy with which the diversity of feedback samples can be increased while the redundancy is decreased. The authors test our method on a TerraSAR-X image database and compare it with four other state-of-the-art RF methods. The superiority and validity of the authors` method is proved by the retrieval results and the computing cost is acceptable for image retrieval applications. [J150]

"Assessment and analysis of radio frequency compatibility among several global navigation satellite systems"

The increasing number of new global navigation satellite systems (GNSS) signals leads to more interference effects on existing and upcoming navigation signals in the same frequency band. GNSS radio frequency compatibility has become a matter of great concern for the system providers and user communities. This study describes a comprehensive methodology for radio frequency compatibility assessment, and analyses the intersystem interference among several GNSS systems. Firstly, the methodology is presented, considering the geometry-dependent and time-varying terms such as space constellation, signal modulation, emission power level, space loss, satellite antenna gain and user receiver characteristic. Then, the intersystem interference is computed for signals where GPS, Galileo, Compass and SBAS systems are sharing the same frequency band. The analysis results show that interference effects on GNSS user receiver from the above-mentioned systems are acceptable. The introduction of Compass system can provide a sound basis for compatibility with GPS and Galileo. [J151]

"Performance Bounds and Angular Resolution Limit for the Moving Colocated MIMO Radar"

To identify a target, the moving noncoherent colocated multiple-input multiple-output (MIMO) radar system takes advantage of multiple antennas in transmission and reception which are close in space. In this paper, we study the estimation performance and the resolution limit for this scheme in which each array geometry is described by the sample-variance of the sensor distribution. So, our analysis encompasses any sensor distributions, including varying intersensors distances or/and lacunar (missing sensors) configuration. As in the space-time MIMO model considered here the radar is moving, the target Doppler frequency cannot be assumed invariant to the target position/angle. The first part of this paper derives and analyzes closed form (nonmatrix) expressions of the deterministic Cramer-Rao lower bound (CRB) for the direction and the velocity of a moving target contaminated by a structured noise (clutter echoes) and a background noise, including the cases of the clutter-free environment and the high signal-to-noise ratio (SNR) regime. The analysis of the proposed expressions of the CRB allows to better understand the characterization of the target. In particular, we prove the coupling between the direction parameter and the velocity of the target is linear with the radar velocity. In the second part, we focus our study on the analytical (closed form) derivation and the analysis of the angular resolution limit (ARL). Based on the resolution of an equation involving the CRB, the ARL can be interpreted as the minimal separation to resolve two closely spaced targets. Consequently, the ARL is a key quantity to evaluate the performance of a radar system. We show that the ARL is in fact quasi-invariant to the movement of the MIMO radar. [J152]

"Wind turbine clutter observations and theoretical validation for meteorological radar applications"

The use of wind energy is gaining importance because of its many advantages. Nations worldwide are promoting the installation of wind farms to produce electricity in an attempt to tackle climate change and increasing oil costs. However, wind turbines can generate undesired signals that disturb the performance of radar systems. In particular, this is an issue for weather radar networks that see wind turbines as clutter, since they have a strong influence on meteorological outputs such as the estimation of rain intensity or wind velocity. This study develops a simulated scenario and a radar signal model that justify collection of live data from the Spanish Weather Radar Network. Simulated and real data are discussed for both the spotlight and exploration modes. As an application example, a simple algorithm has been developed to estimate wind direction in the immediate vicinity of wind turbines. In this context, it is clear that some meteorological information may be extracted from the wind turbine clutter itself. [J153]

"Interferometric inverse synthetic aperture radar experiment using an interferometric linear frequency modulated continuous wave millimetre-wave radar"

An interferometric linear frequency modulated continuous wave (LFMCW) millimetre-wave radar is presented, along with the results of an experiment conducted to study the feasibility of using it in a future millimetre-wave interferometric inverse synthetic aperture radar (InISAR) system. First, a description of the radar is given. Then, the signal processing chain is described, with special attention to the phase unwrapping technique. The interferometric phase is obtained by unwrapping the prominent target's phase in each antenna using a sliding frame processing technique. Cell migration issues in this method are also addressed. Simulations were carried out to illustrate and assess the processing chain and to show the effects of multipath echoes on the height measurement. In the real experiment, the range, speed and height of a moving target were tracked over consecutive inverse synthetic aperture radar (ISAR) image frames, verifying the performance of the whole system. [J154]

"Sparse Learning via Iterative Minimization With Application to MIMO Radar Imaging"

Through waveform diversity, multiple-input multiple-output (MIMO) radar can provide higher resolution, improved sensitivity, and increased parameter identifiability compared to more traditional phased-array radar schemes. Existing methods for target estimation, however, often fail to provide accurate MIMO angle-range-Doppler images when there are only a few data snapshots available. Sparse signal recovery algorithms, including many l1-norm based approaches, can offer improved estimation in that case. In this paper, we present a regularized minimization approach to sparse signal recovery. Sparse learning via iterative minimization (SLIM) follows an lq-norm constraint (for 0 <; q≤ 1), and can thus be used to provide more accurate estimates compared to the l1-norm based approaches. We herein compare SLIM, through imaging examples and examination of computational complexity, to several well-known sparse methods, including the widely used CoSaMP approach. We show that SLIM provides superior performance for sparse MIMO radar imaging applications at a low computational cost. Furthermore, we will show that the user parameter qcan be automatically determined by incorporating the Bayesian information criterion. [J155]

"Existence of Binary -Complementary Pairs"

The conventional binary complementary pairs exist only for very limited lengths, while binary Z-complementary pairs exist for many more lengths. In this letter, an upper bound on zero correlation zone (ZCZ) width of binary Z-complementary pairs of odd length is established. The existence conjecture of binary Z-complementary pairs with ZCZ widths 2, 3, 4, 5 and 6 is completely solved, and a new recursive construction of binary Z-complementary pairs is proposed. [J156]

"Linear Feature Detection in Polarimetric SAR Images"

Recently, the use of linear features for processing remote-sensing images has shown its importance in applications. Unfortunately, traditional linear feature detection methods rely heavily on the image's local information which makes them vulnerable to the presence of noise in the image. This problem becomes particularly difficult for synthetic aperture radar (SAR) image applications where SAR images are corrupted by speckle noise. In order to overcome this problem, we propose a novel method that processes the polarimetric synthetic aperture radar (Pol-SAR) images by combining the multiscale image analysis with polarimetric information in a new fashion. A two-scale approach is adopted here. On a coarse level, the coarse regions of the linear features are extracted by a curvelet transform from a speckle noise reduced image obtained by the polarimetric whitening filter. On a fine level, we develop a fuzzy polarimetric detector to accurately locate the linear features inside the regions. The effectiveness of the proposed method is demonstrated using simulated Pol-SAR data acquired from both EMISAR and Convair-580 systems. [J157]

"Diversity Gain for MIMO Neyman-Pearson Signal Detection"

For a multiple-input multiple-output (MIMO) system adopting the Neyman-Pearson (NP) criterion, we initially derive the diversity gain for a signal-present versus signal-absent scalar hypothesis test statistic and also for a vector signal-present versus signal-absent hypothesis testing problem. For a MIMO radar system with Mtransmit and Nreceive antennas, used to detect a target composed of Qrandom scatterers with possibly non-Gaussian reflection coefficients in the presence of possibly non-Gaussian clutter-plus-noise, we consider a class of test statistics, including the optimum test for Gaussian reflection coefficients and Gaussian clutter-plus-noise, and apply the previously developed results to compute the diversity gain. It is found that the diversity gain for the MIMO radar system is dependent on the cumulative distribution function (cdf) of the reflection coefficients while being invariant to the cdf of the clutter-plus-noise under some reasonable conditions requiring certain moments of the magnitude of the processed clutter-plus-noise be bounded. If the noise-free received waveforms, due to target reflection, at each receiver span a space of dimension $M' \leq M$, the largest possible diversity gain is controlled by the value of $\min(NM', Q)$ and the lowest order power in an expansion, about zero, of the cdf of the magnitude squared of a linear transformed version of the reflection coefficient vector. It is shown that the maximum possible diversity gain in any given scenario can be achieved without employing orthogonal waveforms. [J158]

"Adaptive Model-Based Decomposition of Polarimetric SAR Covariance Matrices"

Previous model-based decomposition techniques are applicable to a limited range of vegetation types because of their specific assumptions about the volume scattering component. Furthermore, most of these techniques use the same model, or just a few models, to characterize the volume scattering component in the decomposition for all pixels in an image. In this paper, we extend the model-based decomposition idea by creating an adaptive model-based decomposition technique, allowing us to estimate both the mean orientation angle and a degree of randomness for the canopy scattering for each pixel in an image. No scattering reflection symmetry assumption is required to determine the volume contribution. We examined the usefulness of the proposed decomposition technique by decomposing the covariance matrix using the National Aeronautics and Space Administration/Jet Propulsion Laboratory Airborne Synthetic Aperture Radar data at the C-, L-, and P-bands. The randomness and mean orientation angle maps generated using our adaptive decomposition significantly improve the physical interpretation of the scattering observed at the three different frequencies. [J159]

"Analysing and compensating the effects of range and Doppler frequency migrations in linear frequency modulation pulse compression radar"

The pulse compression and Doppler processing (PCDP) method has been extensively used to detect low-speed and uniform-speed targets in linear frequency modulation (LFM) pulse compression radar. However, the PCDP method is affected by range migration (RM) and Doppler frequency migration (DFM) when detecting high-speed and accelerating targets. In this paper, the authors analyse and quantify these effects, and obtain the relationships of the optimal number of pulses and the threshold number of pulses with RM and DFM. It shows

that when the number of pulses equals its optimal value, the maximum output signal-to-noise ratio can be obtained; when the number of pulses is greater than its threshold value, the migrations should be compensated. Then the authors propose a method based on the scaling processing and the fractional Fourier transform to remove the two migrations. In the end, the authors give a target detection experiment to show that the proposed method can effectively compensate these migrations. [J160]

"Sight Line Rate Estimation in Missile Seeker Using Disturbance Observer-Based Technique"

Filtering of base motion disturbance from the sight line rate is necessary for homing guidance of missiles. The present work proposes using a noninvasive seeker filter based on the disturbance observer concept to extract the target sight line rate signal from the raw signal corrupted with base motion disturbance. It is shown that the disturbance observer-based filter in favorable (nominal) condition can totally eliminate the platform motion from the raw sight line rate signal. The performance of the filter for off-nominal condition is also derived and exemplified. Simulation results demonstrate improved performance of the proposed filter compared to previously reported schemes. [J161]

"Multiscale Compressed Block Decomposition for Fast Direct Solution of Method of Moments Linear System"

The multiscale compressed block decomposition algorithm (MS-CBD) is presented for highly accelerated direct (non iterative) solution of electromagnetic scattering and radiation problems with the method of moments (MoM). The algorithm is demonstrated to exhibit N2computational complexity and storage requirements scaling with N1.5, for electrically large objects. Several numerical examples illustrate the efficiency of the method, in particular for problems with multiple excitation vectors. The largest problem presented in this paper is the monostatic RCS of the NASA almond at 50 GHz, for one thousand incidence angles, discretized using 442,089 RWG basis functions. Being entirely algebraic, MS-CBD is independent of the Greens function of the problem. [J162]

"Ship detection by different data selection templates and multilayer perceptrons from incoherent maritime radar data"

This study presents a novel way for detecting ships in sea clutter. For this purpose, the information contained in the Radar images obtained by an incoherent X-band maritime Radar is used. The ship detection is solved by feedforward artificial neural networks, such as the multilayer perceptrons (MLPs). In a first approach, the MLP processes the information extracted from the Radar images using the commonly used horizontal and vertical selection templates. But, if a suitable combination of these selection templates is done, better detection performances are achieved. So, two improved selection templates are proposed, which are based on cross and plus shapes. All these templates are also applied in a commonly used detector taken as reference, the CA-CFAR detector. Its performance is compared with the one achieved by the proposed detector. This comparison shows how the MLP-based detector outperforms the CA-CFAR detector in all the cases under study. The results are presented in terms of objective (probabilities of false alarm and detection) and subjective estimations of their performances. The improved MLP-based detector also presents low computational cost and high robustness in its performance against changes in the sea conditions and ship properties. [J163]

"Sparse representation-based synthetic aperture radar imaging"

There is increasing interest in using synthetic aperture radar (SAR) images in automated target recognition and decision-making tasks. The success of such tasks depends on how well the reconstructed SAR images exhibit certain features of the underlying scene. Based on the observation that typical underlying scenes usually exhibit sparsity in terms of such features, this paper presents an image formation method that formulates the SAR imaging problem as a sparse signal representation problem. For problems of complex-valued nature, such as SAR, a key challenge is how to choose the dictionary and the representation scheme for effective sparse representation. Since features of the SAR reflectivity magnitude are usually of interest, the approach is designed to sparsely represent the magnitude of the complex-valued scattered field. This turns the image reconstruction problem into a joint optimisation problem over the representation of magnitude and phase of the underlying field reflectivities. The authors develop the mathematical framework for this method and propose an iterative solution for the corresponding joint optimisation problem. The experimental results demonstrate the superiority of this method over previous approaches in terms of both producing high-quality SAR images and exhibiting robustness to uncertain or limited data. [J164]

"Theoretical and experimental study of a signal feature extraction algorithm for measuring propeller acceleration in a port surveillance system"

Classification and identification of moving vessels by extracting particular features of the underwater radiated noise generated by the propellers for use within a port area are an attractive topic for a port underwater surveillance system. The authors first present a chirp-periodic signal model for the envelope of accelerating propeller noise, then derive the maximum-likelihood estimator (MLE) for the evaluation of acceleration and finally propose a novel algorithm for the extraction of acceleration feature on modulated noise (EAFOMN) of the propellers. In addition, a series of experiments were performed for an accelerating propeller in a large cavitation tunnel. The results of the tests show that the actual signal features of accelerating propeller noise is consistent with the presented theoretical analysis, and the proposed algorithm is efficient for passively extracting acceleration of propeller rotation speed. [J165]

"An Iterative Least Square Approach to Elastic-Lidar Retrievals for Well-Characterized Aerosols"

An iterative least square method is presented for estimating the solution to the lidar equation. The method requires knowledge of the backscatter values at a boundary point for all channels and a priori defined relationships between backscatter, extinction, and mass-fraction concentration for all scattering components. The lidar equation is formulated in vector form, and a solution is computed using an iterative least square technique. The solution is stable for signals with extremely low signal-to-noise ratios and for signals at ranges far beyond the boundary point. The solution can be applied to lidar signals with an arbitrary number of wavelengths and scattering components. [J166]

"DataWare: Sea Clutter and Small Boat Radar Reflectivity Databases [JBest of the Web]"

In this issue, "Best of the Web" presents online radar reflectivity databases, which are free of charge to the international research community. Databases such as these are used for the characterization of interference (including noise, sea clutter and land clutter, among others) in radar systems, and the development of signal processing techniques that reduce the detrimental effects of this unwanted interference. The data can also be used for the development and evaluation of signal processing techniques aimed at detecting and tracking man-made objects by separating targets from interference based on Doppler and amplitude characteristics. These signal processing techniques include moving target indication (MTI), pulse-Doppler, space-time adaptive processing, track-before-detect (TkBD), and constant false alarm rate (CFAR) processing. [J167]

"Single and Multipolarimetric SAR Tomography of Forested Areas: A Parametric Approach"

In this paper, a technique is described for the tomographic characterization of forested areas through multiple synthetic aperture radar (SAR) observations, based on either single or multipolarimetric acquisitions. This technique is based on the idea of characterizing the Fourier spectrum of the multibaseline data as being constituted by two effective scattering centers displaced along the vertical direction, plus the associated decorrelation terms. As a result, SAR tomography will be formulated as the problem of detecting the number of scattering centers within the resolution cell, estimating the parameters that describe their spatial structure, and evaluating the associated backscattered powers. Parameter estimation is carried out through the covariance matching estimation technique, which provides an asymptotically optimal solution. The results of an experiment performed on a real P-band multibaseline fully polarimetric data set relative to the forested site of Remningstorp, Sweden, are reported. [J168]

"Predicting Millimeter Wave Radar Spectra for Autonomous Navigation"

Millimeter Wave (MMW) radars are currently used as range measuring devices in applications such as automotive driving aids (Langer and Jochem, 1996), (Rohling and Mende, 1996), the mapping of mines (Brooker et al., 2005) and autonomous field robotics (Brooker, 2001), (Langer, 1996). This recent interest is largely due to the advantages MMW radars offer over other range measuring sensors, as their performance is less affected by dust, fog, rain or snow and ambient lighting conditions. MMW radars can provide received signal strength values, at all discrete range intervals, within the working range of the radar (Clark and Durrant-Whyte, 1997), (Scheding et al., 2002). The received power versus range spectra hence contain useful range to target information, but are also corrupted by noise. User defined stochastic algorithms can then be implemented, which exploit this rich data to improve object detection and mapping performance. This is in contrast to many other range measuring devices which typically internally threshold received signals, to provide single hard decisions only, on the estimated range to objects (Mullane, 2007). This paper addresses the issues of predicting the power-range spectra from MMW radars which use the Frequency Modulated Continuous Wave (FMCW) range estimation technique. This is important for two reasons. First, in automotive and autonomous robotic applications, such sensors are used in conjunction with vehicle navigation and map state estimation filters. This is so that (typically uncertain) vehicle motion knowledge can be optimally fused with the noisy sensor information, to infer estimates of the state of interest (typically, the vehicle's pose (position and orientation) and/or information of the

surrounding object locations). Hence, it is essential that predicted power versus range spectra can be computed, to apply a Bayesian recursive estimation framework, based on previous measurements, and uncertain vehicle motion information. Second, it- is extremely useful to be able to simulate MMW radar data, given certain environmental configurations. This aids the development of reliable object detection algorithms, based on theoretical sensor and noise models, which can then be applied more effectively to real MMW radar data. [J169]

"Fast OMP algorithm for 2D angle estimation in MIMO radar"

A high-dimensional sparse signal usually should be realigned as a long 1D signal to be recovered by orthogonal matching pursuit (OMP), an efficient algorithm for compressed sensing. Clearly, however, the realigned long signal will result in a large amount of computation in OMP. If each atom in the dictionary can be expressed as the Kronecker product of two vectors, it can possible to decompose this dictionary into two sub-dictionaries. By exploiting this property, a fast OMP algorithm for 2D sparse signals of this kind is presented, and applied to 2D angle estimation in MIMO radar. Simulation results verify its good reconstruction quality approximate to that of OMP and greatly improved computational efficiency. [J170]

"Experimental Verification of SAR-GMTI Improvement Through Antenna Switching"

Recently, theoretical investigations have shown that switching between parts of the transmit and/or receive aperture in a pulse-to-pulse cycle may improve the ground moving target indication (GMTI) performance of a two-channel radar system. This paper intends to verify these findings experimentally for the switching concept for the first time. Accordingly, six different GMTI modes were implemented in the system PAMIR (phased-array multifunctional imaging radar) of the Fraunhofer Institute for High Frequency Physics and Radar Techniques (Fraunhofer FHR) including three switching modes. An experiment was conducted using six cooperative vehicles following a predefined scenario to compare the GMTI performance and, in particular, the positioning accuracy of the different GMTI modes. The results of this experiment as well as the underlying signal processing are presented in this paper. The analysis is based on a multilook constant false-alarm rate detection scheme. Due to the heterogenous nature of the considered scene, the well-known test statistic for homogeneous terrain had to be extended accordingly, and a novel test statistics is proposed. [J171]

"Soil Moisture Effect on Thermal Infrared (8-13-μm) Emissivity"

Thermal infrared (TIR) emissivities of soils with different textures were measured for several soil moisture (SM) contents under controlled conditions using the Box method and a high-precision multichannel TIR radiometer. The results showed a common increase of emissivity with SM at water contents lower than the field capacity. However, this dependence is negligible for higher water contents. The highest emissivity variations were observed in sandy soils, particularly in the 8-9-μm range due to water adhering to soil grains and decreasing the reflectance in the 8-9-μm quartz doublet region. Thus, in order to model the emissivity dependence on soil water content, different approaches were studied according to the a priori soil information. Soil-specific relationships were provided for each soil texture and different spectral bands between 8 and 13 μm, with determination coefficients up to 0.99, and standard estimation errors in emissivity lower than ± 0.014. When considering a general relationship for all soil types, standard estimation errors up to ±0.03 were obtained. However, if other soil properties (i.e., organic matter, quartz, and carbonate contents) were considered, along with soil water content, the general relationship predicted TIR emissivities with a standard estimation error of less than ±0.008. Furthermore, the study showed the possibility of retrieving SM from TIR emissivities with a standard estimation error of about ±0.08 m3. m-3. [J172]

"Radar Imaging From Geosynchronous Orbit: Temporal Decorrelation Aspects"

Synthetic aperture radar imaging from geosynchronous orbit has significant potential advantages over conventional low-Earth orbit radars, but it also has challenges to overcome. The baseline mission we consider is an L-band geosynchronous passive (bistatic) radar achieving a spatial resolution of about 100 m with an integration time of 8 h. The atmosphere changes its structure on timescales of minutes to hours, and this has to be compensated if useful images are to be provided. The analysis shows that ionospheric delay is the major source of temporal decorrelation; other effects, such as tropospheric delay and Earth tides, have to be dealt with but appear to be easier to handle. [J173]

"Synthetic Aperture Radar Processing with GPGPU"

This article focuses on methodologies with recurrent use to code examples that try to couple with the flow of the main steps of the SAR processing. The possibility to be comprehensive was prevented by the wide scenario of variations of the focusing algorithm as well as the spread of applications. The reader should look at this work as a sample of possibilities offered by this new technology and a collection of suggestions and considerations that

may guide to new applications and horizons. [J174]

"Two Novel Bayesian Multiscale Approaches for Speckle Suppression in SAR Images"

Speckle suppression is a prerequisite for many synthetic aperture radar (SAR) image-processing tasks. Previously, we introduced a Bayesian-based speckle-suppression method that employed the 2-D generalized autoregressive conditional heteroscedasticity (2D-GARCH) model for wavelet coefficients of log-transformed SAR images. Based on this method, we propose two new Bayesian speckle-suppression approaches in this paper. In the first approach, we introduce a new heteroscedastic model, i.e., the 2D-GARCH Mixture (2D-GARCH-M) model, as an extension of the 2D-GARCH model. This new model can capture the characteristics of wavelet coefficients. Also, the 2D-GARCH-M model introduces additional flexibility in the model formulation in comparison with the 2D-GARCH model, which results in better characterization of SAR image subbands and improved restoration in noisy environments. Then, we design a Bayesian estimator for estimating the clean-image wavelet coefficients based on 2D-GARCH-M modeling. In the second approach, the logarithm of an image is analyzed by means of the curvelet transform instead of wavelet transform. Then, we study the statistical properties of curvelet coefficients, and we demonstrate that the 2D-GARCH model can capture the characteristics of curvelet coefficients, such as heavy tailed marginal distribution, and the dependences among them. Consequently, under the 2D-GARCH model, we design a Bayesian estimator for estimating the clean-image curvelet coefficients. Finally, we compare these methods with other denoising methods applied on artificially speckled and actual SAR images, and we verify the performance improvement in utilizing the new strategies. [J175]

"Joint Elevation and Azimuth Direction Finding Using L-Shaped Array"

For two-dimensional (2-D) directions-of-arrival (DOA) estimation problem, the L-shaped array seems to have higher accuracy than other structured arrays [see ??An L-shaped array for estimating 2-D directions of wave arrival?? by Hua for details], and has received much attention. To estimate elevation and azimuth angles, two correctly matched electric angles (functions of elevation and azimuth angles) are estimated in advance, so that elevation and azimuth angles are obtained from the two correctly matched electric angles. However, the failure in pairing will cause severe performance degradation. In this communication, a novel algorithm, which doesn't require match procedure, is proposed to estimate 2-D DOA in the L-shaped array geometry. The key points of this communication are: i) by introducing a novel electric angle, the steering vector is separated into two parts; ii) the two parts can be obtained in turn by generalized ESPRIT approach and eigenvalue decomposition (EVD) of one particular matrix, respectively; iii) elevation and azimuth angles can be obtained from the recovered steering vector. The resultant algorithm avoids match operation, and requires one-dimensional search once. Simulation results are presented to validate the performance of the proposed method. [J176]

"Cauchy Estimation for Linear Scalar Systems"

An estimation paradigm is presented for scalar discrete linear systems entailing additive process and measurement noises that have Cauchy probability density functions (pdf). For systems with Gaussian noises, the Kalman filter has been the main estimation paradigm. However, many practical system uncertainties that have impulsive character, such as radar glint, are better described by stable non-Gaussian densities, for example, the Cauchy pdf. Although the Cauchy pdf does not have a well defined mean and does have an infinite second moment, the conditional density of a Cauchy random variable, given its linear measurements with an additive Cauchy noise, has a conditional mean and a finite conditional variance, both being functions of the measurement. For a single measurement, simple expressions are obtained for the conditional mean and variance, by deriving closed form expressions for the infinite integrals associated with the minimum variance estimation problem. To alleviate the complexity of the multi-stage estimator, the conditional pdf is represented in a special factored form. A recursion scheme is then developed based on this factored form and closed form integrations, allowing for the propagation of the conditional mean and variance over an arbitrary number of time stages. In simulations, the performance of the newly developed scalar discrete-time Cauchy estimator is significantly superior to a Kalman filter in the presence of Cauchy noise, whereas the Cauchy estimator deteriorates only slightly compared to the Kalman filter in the presence of Gaussian noise. Remarkably, this new recursive Cauchy conditional mean estimator has parameters that are generated by linear difference equations with stochastic coefficients, providing computational efficiency. [J177]

"The Phased Array Is the Maximum SNR Active Array [JLecture Notes]"

Active arrays are widely used in many sensing applications, including radar, sonar, and medical imaging. It is often stated without proof that the phased array maximizes the SNR at a given focal point over the class of possible active arrays. The proof here of this statement, under various conditions, provides new insight into the

use of active arrays in diverse sensing applications. Courses that may benefit from this article include array signal processing, radar, sonar, and medical imaging. [J178]

"MATLAB for Signal Processing on Multiprocessors and Multicores"

MATLAB is a popular choice for algorithm development in signal and image processing. While traditionally done using sequential MATLAB running on desktop systems, in recent years there has been a surge of interest in running MATLAB in parallel to take advantage of multiprocessor and multicore systems. In this article, we discuss three variations of multiprocessor parallel MATLAB, two of which are available as commercial, supported products. We also consider running MATLAB with key computations speeded up using multithreaded computations on multicore general-purpose graphical processing units (GPGPUs). Two signal processing kernels (fast Fourier transform (FFT) and convolution) and two full applications [synthetic aperture radar (SAR) imaging and superconducting quantum interference devices (SQIF)] are used to illustrate the use of parallel MATLAB. [J179]

"AMSAR-A European success story in AESA radar"

DGA, BWB and D&ES initiated a radar programme, called AMSAR (Airborne Multi-role Solid-state Active-array Radar) to demonstrate the enormous potential of Active Electronically Scanned Array (AESA) radar. This describes all stages of the AMSAR project and the results obtained. The AMSAR demonstrator is still the only European, forward-looking multi-channel active array radar with the capability of recording the outputs of more than 4 quadrants. [J180]

"UK airborne AESA radar research"

This reviews current UK airborne active electronically scanned array (AESA) designs, discusses current trends toward higher digitisation and multi-function aperture concepts, and details key future challenges that this technology faces. Specifically, we discuss applications to fast-jets. Key requirements are for higher levels of digitisation to provide the performance required in ECCM, STAP, GMTI, and ESM modes. Building radar systems with the key basic building blocks to, as a minimum, enable future realisation of these advanced modes will help to Г‚Вїfuture proofГ‚Вї the systems. This design philosophy is integral to the concept of through life capability management (TLCM); Le., a system designed to support the ability to sustain capability through incremental, spiral upgrades of signal processing, line replaceable items (LRIs), firmware, and advanced modes. [J181]

"An Efficient and Flexible Statistical Model Based on Generalized Gamma Distribution for Amplitude SAR Images"

In the context of synthetic aperture radar (SAR) image processing and applications, the precise modeling of statistical knowledge is a crucial problem. In this paper, an efficient and flexible statistical model, called generalized Gamma Rayleigh (G??R) distribution, for amplitude SAR images is proposed by assuming a two-sided generalized Gamma distribution for the real and imaginary parts of the complex SAR backscattered signal. It is shown that the Rayleigh and recently proposed generalized Gaussian Rayleigh distributions can be regarded as special cases of G??R distribution. Considering that the probability density function estimation problem is formulated as a parameter estimation one for the parametric statistical analysis of SAR images, a two-stage estimator based on second-kind cumulants is derived for the parameters of G??R distribution. Furthermore, experimental results on several actual SAR images are given to demonstrate the validity and flexibility of the proposed model. [J182]

"Earthquake Damage Assessment of Buildings Using VHR Optical and SAR Imagery"

Rapid damage assessment after natural disasters (e.g., earthquakes) and violent conflicts (e.g., war-related destruction) is crucial for initiating effective emergency response actions. Remote-sensing satellites equipped with very high spatial resolution (VHR) multispectral and synthetic aperture radar (SAR) imaging sensors can provide vital information due to their ability to map the affected areas with high geometric precision and in an uncensored manner. In this paper, we present a novel method that detects buildings destroyed in an earthquake using pre-event VHR optical and post-event detected VHR SAR imagery. The method operates at the level of individual buildings and assumes that they have a rectangular footprint and are isolated. First, the 3-D parameters of a building are estimated from the pre-event optical imagery. Second, the building information and the acquisition parameters of the VHR SAR scene are used to predict the expected signature of the building in the post-event SAR scene assuming that it is not affected by the event. Third, the similarity between the predicted image and the actual SAR image is analyzed. If the similarity is high, the building is likely to be still intact, whereas a low similarity indicates that the building is destroyed. A similarity threshold is used to classify the buildings. We demonstrate the feasibility and the effectiveness of the method for a subset of the town of

Yingxiu, China, which was heavily damaged in the Sichuan earthquake of May 12, 2008. For the experiment, we use QuickBird and WorldView-1 optical imagery, and TerraSAR-X and COSMO-SkyMed SAR data. [J183]

"Capon- and APES-Based SAR Processing: Performance and Practical Considerations"

This paper discusses the use of Capon's minimum-variance method (MVM) and Amplitude and Phase EStimation (APES) spectral-estimation algorithms to synthetic aperture radar range-azimuth focusing. The rationale of the algorithms is discussed. An implementation of a Capon or APES processing chain is explained, and processing parameters such as chip-image size, resampling factor, and diagonal loading are discussed. For multichannel cases, a joint-processing approach is presented. A set of Monte Carlo simulations are described and used to benchmark Capon- and APES-based processing against conventional matched-filter-based approaches. Both methods improve the resolution and reduce sidelobes. APES yields generally better estimates of amplitude and phase than Capon but with worse resolution. Results with RADARSAT-2 quad-polarization data over Barcelona are used to qualitatively study the real-life performance of these algorithms. [J184]

"Modeling of Fluorescence Lidar ROC Curves"

In this paper, an analytical model of a receiver operating characteristic (ROC) curve for digital fluorescence lidar sensing of an aerosol biowarfare agent (BWA) simulant in the presence of a single aerosol interferent is presented. The BWA simulant and interferent are characterized by their concentrations, particle size distributions, fluorescence cross sections, and complex refractive indexes. The ROC curve calculation is performed for simulant and interferent lidar signals that are plotted in a biodiscrimination plane defined by normalized particle size ratio Xand particle fluorescence ratio Y. Probability density functions (PDFs) of BWA simulant and interferent in the biodiscrimination plane are due to finite signal-to-noise lidar measurements. These functions are modeled with a joint distribution density function of Xand Yas correlated variables. The Xand Yvariables are calculated from the corresponding lidar equations that compute signal and noise from elastic backscatter and fluorescence cross sections, the concentration of aerosol particles, and lidar optical system parameters. Elastic backscatter is calculated from Mie scattering theory using a particle size distribution approximated by a log-normal distribution. Fluorescence cross sections of BWA simulant or interferent aerosols given in the literature are approximated as being independent/dependent from particle size distribution in the model. Each point of the ROC curve of BWA simulant in the presence of an interferent is defined as the integral of the interferent PDF over the elliptical contour projection of BWA simulant PDF in the biodiscrimination plane for a fixed threshold of aerosol cloud detection, and thus, a fixed probability of aerosol cloud detection. Presented ROC curve method can be generalized to the case of the simultaneous presence of several interferents to the discrimination of one BWA simulant. Calculated elliptical contour projections of- the bioaerosol PDF in the biodiscrimination plane, and corresponding ROC curves are computed and presented for the parameters of an experimental lidar that was tested during BWA simulant and interferent aerosol cloud releases, where aerosol cloud particle concentrations and size distributions were also measured. When the number and identity of interferents and their corresponding concentrations are unknown, the ROC curve can be estimated by assuming a constant bioaerosol PDF in the biodiscrimination plane. [J185]

"Workshop on multistatic and MIMO radar"

MIMO radar should not be regarded as a separate subject, but rather as part of a continuum of different types of diverse, networked radar sensors. [J186]

"Iterative Adaptive Kronecker MIMO Radar Beamformer: Description and Convergence Analysis"

We introduce an iterative procedure for design of adaptive KL-variate linear beamformers that are structured as the Kronecker product of K-variate (transmit) and L-variate (receive) beamformers. We focus on MIMO radar applications for scenarios where only joint transmit and receive adaptive beamforming can efficiently mitigate multi-mode propagated backscatter interference. This is because the direction-of-departure (DoD) on one interference mode, and the direction-of-arrival (DoA) on the other, coincide with those of a target, respectively. We introduce a Markov model for the adaptive iterative routine, specify its convergence condition, and derive final (stable) signal-to-interference-plus-noise ratio (SINR) performance characteristics. Simulation results demonstrate high accuracy of the analytical derivations. In addition, we demonstrate, that for the considered class of multiple-input multiple-output (MIMO) radar interference scenarios, the diagonally loaded sample matrix inversion (SMI) algorithm provides additional performance improvement and convergence rate for this iterative adaptive Kronecker beamformer. [J187]

"Tropical Cyclone Intensity Estimated From Wide-Swath SAR Images"

Due to the relatively small amount of in situdata available for the open oceans, remote sensing techniques take

an important role in the retrieval of geophysical information, particularly during extreme events. The work presented here aims at the improvement of prediction of cyclone intensity using synthetic aperture radar (SAR) images. A new method to measure the hurricane intensity using SAR images, in combination with a parametric Holland-type model of wind speed, is presented. The algorithm is based on a least square minimization of the difference between the parametric model results and the SAR measurement. The radius of the maximum wind speed, required as input for the minimization procedure, is estimated from the SAR image using wavelet analysis. Information on wind direction is extracted from the SAR image through analysis of image features caused by boundary layer rolls. The root-mean-square error of the suggested method has been validated to be equal to 3.9 m/s. The study is based on a data set of wide-swath SAR images of about 400 km ?? 400 km coverage, acquired by the European Envisat satellite, over tropical cyclones. As a case study, hurricane Katrina is investigated in detail. A total of five tropical cyclone images will be used to validate the results of the new algorithm. [J188]

"Dry-Wet Bedrock Interface Detection by Radio Echo Sounding Measurements"

In this paper, a method to distinguish a wet or dry bedrock-ice interface is proposed. It is based on the analysis of radio echo sounding (RES) measurements, a widely employed method for determining bedrock topography in Antarctica. In particular, the RES system has played an important role in subglacial lake exploration and hydrogeological studies at the bedrock-ice interface. Recently, bedrock characterization has been improved through the analysis of the power of radar echoes. Signal power depends on bedrock reflectivity and its specific physical condition. In this paper, a linear model describing the loss term (internal ice absorption) is proposed. This model, together with other known quantities, contributes toward an assessment of power variation of bedrock reflectivity in order to determinate wet and dry bedrock interfaces in the Dome C region in Antarctica. [J189]

"Multichannel Azimuth Processing in ScanSAR and TOPS Mode Operation"

Due to a system-inherent limitation, conventional synthetic aperture radar (SAR) is incapable of imaging a wide swath with high geometric resolution. This restriction can be overcome by systems with multiple receive channels in combination with an additional digital signal processing network. So far, the application of such digital beamforming algorithms for high-resolution wide-swath SAR imaging has been restricted to multichannel systems in stripmap operation. However, in stripmap mode, the overall azimuth antenna length restricts the achievable swath width, thus preventing very wide swaths as requested by future SAR missions. Consequently, new concepts for ultrawide-swath imaging are needed. A promising candidate is a SAR system with multiple azimuth channels being operated in burst mode. This paper analyzes innovative ScanSAR and Terrain Observation by Progressive Scans (TOPS) system concepts with regard to multichannel azimuth processing. For this, the theoretical analyses, performance figures, and SAR signal processing, which had previously been derived for multichannel stripmap mode, are extended to systems operating in burst modes. The investigations reveal that multichannel ScanSAR systems enable the imaging of ultrawide swaths with high azimuth resolution and compact antenna lengths. These considerations are embedded in a multichannel ScanSAR system design example to demonstrate its capability to image an ultrawide swath of 400 km with a high geometric resolution of 5 m. In a next step, this system is adapted to TOPS mode operation, including an innovative "staircase" multichannel processing approach optimized for TOPS. [J190]

"Motion Parameter Estimation in the SAR System With Low PRF Sampling"

A novel approach to motion parameter estimation with low pulse repetition frequency (PRF) sampling based on compressed sensing (CS) theory is introduced. As is known to us, when PRF is less than the Doppler spectrum bandwidth, moving targets suffer both Doppler centroid frequency ambiguity and Doppler spectrum ambiguity. Under this condition, the traditional parameter estimation method in the Doppler domain is out of action. The key of this letter converts motion parameter estimation in the synthetic aperture radar system with low PRF sampling into solving an optimization equation based on CS theory. Because moving targets in the scene can be regarded as sparse signals after clutter cancellation, an optimization algorithm based on CS theory is proposed to reconstruct sparse signals and meanwhile estimate the along-track velocities and azimuth positions of moving targets. Considering the fact that range cell migration of moving targets is not subject to PRF limitations, Radon transform is adopted to obtain unambiguous across-track velocities and range positions. Results on simulation and real data are provided to show the effectiveness of this method. [J191]

"Practical applications of UWB technology"

Use of ultra-wideband (UWB) technology in various areas for remote sensing of the objects at short distances are considered. As an illustration UWB radar, in medicine and in psychophysiology, for remote measuring of

patient's beating of the pulse and respiration is shown. The opportunity of UWB technology application in the other areas is described, including measuring of liquid levels, definition of a position of people in buildings, and position of people in woodlands. [J192]

"Split slot ring spatial quasi-circulator for RCS characterisation"

A prototype X-band scale model for a quasi-optical three-port circulator utilising a double-layer circularly polarising frequency selective surface is proposed. The operating principles and measured characteristics of the device are discussed. A prototype device operating at 9.9 GHz has been built and validated experimentally. The port 1 to port 2 insertion loss of the quasi-circulator has been measured to be 2 dB, while port 1 to port 3 isolation is 16 dB. It is demonstrated that port 1 to 3 isolation can be increased to 25 dB by embedding the quasi-circulator in a feedforward setup. [J193]

"High-Sensitivity Software-Configurable 5.8-GHz Radar Sensor Receiver Chip in 0.13- m CMOS for Noncontact Vital Sign Detection"

In this paper, analyses on sensitivity and link budget have been presented to guide the design of high-sensitivity noncontact vital sign detector. Important design issues such as flicker noise, baseband bandwidth, and gain budget have been discussed with practical considerations of analog-to-digital interface and signal processing methods in noncontact vital sign detection. Based on the analyses, a direct-conversion 5.8-GHz radar sensor chip with 1-GHz bandwidth was designed and fabricated. This radar sensor chip is software configurable to set the operation point and detection range for optimal performance. It integrates all the analog functions on-chip so that the output can be directly sampled for digital signal processing. Measurement results show that the fabricated chip has a sensitivity of better than -101 dBm for ideal detection in the absence of random body movement. Experiments have been performed successfully in laboratory environment to detect the vital signs of human subjects. [J194]

"Toward SMOS L4 SSS Products: Improving L3 SSS With Auxiliary SSS Data"

The Soil Moisture and Ocean Salinity (SMOS) mission will provide for the first time satellite observations of sea-surface salinity (SSS). At level 3 (L3) of the SMOS processing chain, a large amount of SSS data obtained by the satellite will be summarized in gridded products with the aim of synthesizing the information and reducing the error of individual SSS observations. A further improvement of SSS maps could come from the combination of L3 products with auxiliary SSS data from Argo buoys, ships of opportunity, or moored oceanographic stations. In this paper, we investigate the benefits of combining SMOS data with different auxiliary data sets. We show that the greatest error reductions come from the increase in the spatial-data coverage, even if the temporal coverage is scarce. Conversely, redundant information (i.e., many observations close to each other) or very localized measurements, even if they have a high temporal resolution, do not provide a significant improvement of the SSS products. We show that the most useful auxiliary data in terms of improving the analysis accuracy are those obtained in areas where SMOS data are noisier or, as a second choice, where the SSS field has a large variance. We also show that for areas with the same error in the L3 product (whatever the source of those errors is), it is more advisable to place the auxiliary observations in areas with longer correlation length scales. [J195]

"Numerical Backscattering Analysis for Rough Surfaces Including a Cloddy Structure"

In recent years, the presence of a new type of agricultural-surface tillage used for the sowing of wheat and corn has been observed with increasing frequency. It illustrates less roughly ploughed soils, with a greater quantity of small clods distributed over the soil surface. In this paper, a new description of such rough agricultural surfaces is proposed. It is based on a composite model, including a classical surface represented by an exponential correlation function, together with a random cloddy structure. This description enables volumetric structures to be introduced over the soil's surface. A numerical moment-modeling method, based on integral equations, is used to evaluate the contribution of clods to the radar backscattering behavior of agricultural surfaces. It is found that the presence of clods explains the very small correlation lengths which are often found in cloddy agricultural fields. The classical approach, in which the surface is described by a correlation function only based on two statistical parameters, rms height and correlation length, overestimates the backscattering coefficients when compared with an approach that includes the clods. This overestimation is often observed with real radar data for such fields. [J196]

"Estimation and Error Analysis of Woody Canopy Leaf Area Density Profiles Using 3-D Airborne and Ground-Based Scanning Lidar Remote-Sensing Techniques"

Vertical profiles of the leaf area density (LAD) of a Japanese zelkova canopy were estimated by combining airborne and portable ground-based light detection and ranging (lidar) data and using a voxel-based canopy profiling method. The profiles obtained by the two types of lidars complemented each other, eliminating blind regions and yielding more accurate LAD profiles than could be obtained by using each type of lidar alone. In the combined results, the mean absolute errors (MAEs) of LAD ranged from 0.20 to 0.42 m2m-3, and the mean absolute percentage errors (MAPEs) of the leaf area index (LAI) ranged from 22.3% to 27.2%, for ground areas from 4 to 32 m2, respectively. A laser beam coverage index ?? incorporating the lidar's beam settings and a beam attenuation factor was proposed. This index showed general applicability to explain the LAD estimation error for LAD measurements using different types of lidars and with different beam settings. Parts of the LAD profiles that were underestimated even when data from both lidars were combined were interpolated by using a Gaussian function. The interpolation yielded improved results for ground areas of 16 and 32 m2; the respective MAEs of LAD were 0.17 and 0.11 m2m-3, and the respective MAPEs of LAI were 8.0% and 9.4%. The proposed method improves lidar-derived LAD estimation and is adapted to broadleaved canopies. The index ?? was tested against an actual canopy scenario and could be used to determine appropriate lidar measurement settings when data from different sources of lidar data are combined to estimate LAD profiles. [J197]

"HF Radio-Frequency Interference Mitigation"

The dense radio-frequency interference (RFI) distributed on the spectrum in the high-frequency band greatly degrades the performance of radio systems and makes it urgent to find an effective and speedy method to eliminate the interferences. The interference mitigation method introduced in this letter is implemented before any further signal processing. It reconstructs the interference by the exactly estimated frequency, amplitude, and phase parameters in the signal spectrum and then subtracts the artificial interference from the input time-domain complex signal. The procedure steps of the method are illustrated in detail. The data stream of continuous oblique-incident ionospheric detection has been processed effectively and rapidly in real time. Several delay-Doppler ionograms severely contaminated by RFI are selected and presented. Comparisons of the original and mitigated ionograms and the signal-to-noise ratio (SNR) data show that the RFIs are eliminated perfectly and that the SNR is greatly improved. [J198]

"Modeling Envisat RA-2 Waveforms in the Coastal Zone: Case Study of Calm Water Contamination"

Radar altimeters have so far had limited use in the coastal zone, the area with most societal impact. This is due to both lack of, or insufficient accuracy in the necessary corrections, and more complicated altimeter signals. This letter examines waveform data from the Envisat RA-2 as it passes regularly over Pianosa (a 10-km2island in the northwestern Mediterranean). Forty-six repeat passes were analyzed, with most showing a reduction in signal upon passing over the island, with weak early returns corresponding to the reflections from land. Intriguingly, one third of cases showed an anomalously bright hyperbolic feature. This feature may be due to extremely calm waters in the Golfo della Botte (northern side of the island), but the cause of its intermittency is not clear. The modeling of waveforms in such a complex land/sea environment demonstrates the potential for sea surface height retrievals much closer to the coast than is achieved by routine processing. The long-term development of altimetric records in the coastal zone will not only improve the calibration of altimetric data with coastal tide gauges but also greatly enhance the study of storm surges and other coastal phenomena. [J199]

"Simulation and Analysis of Human Micro-Dopplers in Through-Wall Environments"

We present a simulation methodology for generating micro-Doppler radar signatures of humans moving behind walls. The method combines primitive-based modeling of humans with finite-difference time-domain (FDTD) simulation of walls. Realistic motions of humans are generated from computer animation data. The time-varying human radar cross section is simulated using the primitive-based prediction technique. The scattered returns of humans behind walls are then simulated by a hybrid of the human simulation model with the through-wall propagation data generated from FDTD. The resulting simulator is used to investigate the effects of walls of both homogeneous and inhomogeneous types on human micro-Dopplers. It is found that while through-wall propagation affects the magnitude response of the Doppler spectrogram in the form of attenuation and fading, it only introduces very minor distortions on the actual Doppler frequencies from the body parts. This is corroborated by measurement data collected using a Doppler radar, as well as by a point-scatterer analysis of refraction and multipath introduced by walls. [J200]

"Signal subspace reconstruction method of MIMO radar"

A novel signal subspace reconstruction method for multiple-input multiple-output (MIMO) radar is proposed. The developed method realises signal subspace resconstruction by the eigendecomposition of two low dimension

matrixes. It provides lower computational complexity and fewer training samples compared to the full DOF method. Simulation results are given to demonstrate the effectiveness of the method. [J201]

"Introduction to the Issue on MIMO Radar and Its Applications"

The 17 papers in this special issue cover various aspects of the latest MIMO radar research and development. [J202]

"Efficient Spotlight SAR MIMO Linear Collection Configurations"

We describe how a family of synthetic aperture radar (SAR) platforms flying linearly and transmitting mutually orthogonal waveforms at a common pulse repetition frequency (PRF) constitute a multiple-input multiple output (MIMO) radar system that reduces time spent collecting a SAR image and quantify the efficiency of such sensor configurations. We give efficient collection configurations for up to 15 platforms as well as asymptotically optimally efficient sequences of configurations. [J203]

"Bird-aircraft strike avoidance radar"

Avian radar system has been developed for bird-aircraft strike hazard avoidance. Two representative systems, which are countrywide and airport-based avian radar systems, are surveyed to summarize the state-of-the-art in this research field. Avian radar experimental system built by Beihang University is introduced in detail, including system architecture, performance analysis, and processing algorithm for bird target detection and tracking. This radar is operated in horizontal and vertical positions alternatively for scanning, and some experimental data are collected, respectively, at reservoir and airport. After processing of background subtraction, noise suppression, target information extraction, tracking and data fusion, a fused image containing bird targets and aircraft is provided. Finally, improvement suggestions on radar antenna, processing algorithms and risk assessment models of bird-aircraft strikes are given. Moreover, a scheme for practical systems applications at airport is proposed. [J204]

"Automatic Extraction of Traffic Flows Using TerraSAR-X Along-Track Interferometry"

Spaceborne synthetic aperture radar (SAR) offers great potential for the measurement of ground traffic flows. A SAR with multiple receiving apertures aligned in flight direction repeatedly images the same ground area with a short time lag. This allows for an effective detection of moving ground objects, whose range variation translates into an interferometric phase signal between the receiving channels. The high-resolution German SAR satellite TerraSAR-X offers several ways to create multiple along-track apertures. We exploit this to demonstrate satellite-based traffic-flow measurements using along-track interferometry (ATI) and Displaced Phase Center Array techniques. In this paper, we address the usage of different TerraSAR-X ATI modes for data acquisition and describe an automatic near-real-time processing chain for the extraction of traffic information. The performance of this TerraSAR-X traffic processor is significantly driven by incorporating a prioriknowledge of road networks. We present examples of automatic traffic detection as well as empirical evaluations thereof using different kind of reference data. [J205]

"Compact quadrature receiver for 24 GHz radar applications in 0.13µm CMOS"

A compact low-noise quadrature receiver for 24 GHz ISM applications in 0.13 µm CMOS technology is presented. The chip offers a conversion gain of 18 dB and a noise figure of 5 dB. The differential circuit consumes only 24 mW from a single 1.5 V supply. The low-noise amplifier, two mixers and on-chip quadrature generation are integrated on a minimal chip area of 0.48 mm2including pads. [J206]

"SAR image heterogeneity and speckle filtering"

The ratio of the arithmetic to the geometric mean, a general index to test synthetic aperture radar (SAR) image homogeneity, is applied to the speckle reducing algorithm. A novel filter, based on improved speckle reducing anisotropic diffusion, is designed to denoise the SAR image. Experiments validate the effectiveness of the proposed method. [J207]

"The TerraSAR-X Satellite"

TerraSAR-X is a versatile synthetic aperture radar (SAR) satellite with active phased array antenna technology and represents the backbone of the German national radar Earth observation mission. With its large variety of different SAR imaging modes and its high operational flexibility, TerraSAR-X ideally serves the scientific community and users from the industrial sector and governmental institutions. The innovative satellite system

design combines the rich experience from past German and European SAR space missions like X-SAR, SRTM, ERS 1 and 2, and Envisat combined with state-of-the-art Earth observation bus technology as used, e.g., on the CHAMP and GRACE satellites. [J208]

"Foreword to the Special Issue on TerraSAR-X: Mission, Calibration, and First Results"

The 34 papers in this special issue provide an overview of the TerraSAR-X mission, commissioning phase, calibration, data processing, and applications. [J209]

"International radar symposium IRS 2009"

Hamburgis the city where Heinrich Hertz was born on February 22, 1857. This was a goodreason to invite the international radar society to Hamburg for the IRS 2009 Radar Symposium. The conference was organized from September 9-11, 2009 at the Crowne Plaza hotel in the city centre. [J210]

"Matched-Illumination Waveform Design for a Multistatic Through-the-Wall Radar System"

We present the matched illumination waveform design for improved target detection in through-the-wall radar imaging and sensing applications. We consider a multistatic radar system for detection of stationary targets with known impulse responses behind walls. The stationary and slowly moving nature of typical indoor targets relaxes the orthogonality requirement on the waveforms, thereby allowing sequential transmissions from each transmitter with simultaneous reception at multiple receivers. The generalization of the matched illumination waveform design concept from a monostatic to a multistatic setting casts the indoor radar sensing problem in terms of multiple-input multiple-output (MIMO) operations and puts in context the offering of MIMO to urban sensing and imaging of targets in enclosed structures. Numerical electromagnetic modeling is used to provide the impulse response of typical behind-the-wall stationary targets, namely tables and humans, for different target orientations and at various incident and reflection angles. Simulation results depict an improvement in the signal-to-clutter-and-noise-ratio (SCNR) at the output of the matched filter receiver for multistatic radar as compared to monostatic operation. [J211]

"From the editor-in-chief [JDr. Philip Woodward, recipient of the IEEE Picard Model]"

Congratulations to Dr. Philip Woodward, recipient of the IEEE Picard Model for his pioneering work in radar waveform design. This award is made by the IEEE Awards Board and was originally to be presented late Spring at the 2009 Radar Conference in California; as it could not be presented then, it was presented in October in Malvern, England, as depicted on our cover. Additional congratulations are extended to Dr. Woodward for receiving the Tompion Medal of the Worshipful Company of Clockmakers for his skills in horology. [J212]

"Iterative Adaptive Approaches to MIMO Radar Imaging"

Multiple-input multiple-output (MIMO) radar can achieve superior performance through waveform diversity over conventional phased-array radar systems. When a MIMO radar transmits orthogonal waveforms, the reflected signals from scatterers are linearly independent of each other. Therefore, adaptive receive filters, such as Capon and amplitude and phase estimation (APES) filters, can be directly employed in MIMO radar applications. High levels of noise and strong clutter, however, significantly worsen detection performance of the data-dependent beamformers due to a shortage of snapshots. The iterative adaptive approach (IAA), a nonparametric and user parameter-free weighted least-squares algorithm, was recently shown to offer improved resolution and interference rejection performance in several passive and active sensing applications. In this paper, we show how IAA can be extended to MIMO radar imaging, in both the negligible and nonnegligible intrapulse Doppler cases, and we also establish some theoretical convergence properties of IAA. In addition, we propose a regularized IAA algorithm, referred to as IAA-R, which can perform better than IAA by accounting for unrepresented additive noise terms in the signal model. Numerical examples are presented to demonstrate the superior performance of MIMO radar over single-input multiple-output (SIMO) radar, and further highlight the improved performance achieved with the proposed IAA-R method for target imaging. [J213]

"2009 IEEE radar conference-A large success"

{no data available} [J214]

"UAV flight plan optimzed for sensor requirements"

To achieve surveillance missions at a safe distance, the UAV surveillance radar shall provide Synthetic Aperture Radar (SAR) images and also SIGINT and EO/IR payloads. This presents the flight plans generated for these

UAV by new generation technologies (genetic algorithms) respecting the constraints of uses of the sensors (angles, distances of recording), the UAV performances (load factor in bend, height of cruise, speed of maximal stamina) as well as the environment of the theatre of operation (relief, meteorology, and restricted zones). [J215]

"MIMO Radar Detection in Non-Gaussian and Heterogeneous Clutter"

In this paper, the generalized likelihood ratio test-linear quadratic (GLRT-LQ) has been extended to the multiple-input multiple-output (MIMO) case where all transmit-receive subarrays are considered jointly as a system such that only one detection threshold is used. The GLRT-LQ detector has been derived based on the spherically invariant random vector (SIRV) model and is constant false alarm rate (CFAR) with respect to the clutter power fluctuations (also known as the texture). The new MIMO detector is then shown to be texture-CFAR as well. The theoretical performance of this new detector is first analytically derived and then validated using Monte Carlo simulations. Its detection performance is then compared to that of the well-known Optimum Gaussian Detector (OGD) under Gaussian and non-Gaussian clutter. Next, the adaptive version of the detector is investigated. The covariance matrix is estimated using the Fixed Point (FP) algorithm which enables the detector to remain texture- and matrix-CFAR. The effects of the estimation of the covariance matrix on the detection performance are also investigated. [J216]

"Transmit Subaperturing for MIMO Radars With Co-Located Antennas"

We present a transmit subaperturing (TS) approach for multiple-input multiple-output (MIMO) radars with co-located antennas. The proposed scheme divides the transmit array elements into multiple groups, each group forms a directional beam and modulates a distinct waveform, and all beams are steerable and point to the same direction. The resulting system is referred to as a TS-MIMO radar. A TS-MIMO radar is a tunable system that offers a continuum of operating modes from the phased-array radar, which achieves the maximum directional gain but the least interference rejection ability, to the omnidirectional transmission based MIMO radar, which can handle the largest number of interference sources but offers no directional gain. Tuning of the TS-MIMO system can be easily made by changing the configuration of the transmit subapertures, which provides a direct tradeoff between the directional gain and interference rejection power of the system. The performance of the TS-MIMO radar is examined in terms of the output signal-to-interference-plus-noise ratio (SINR) of an adaptive beamformer in an interference and training limited environment, where we show analytically how the output SINR is affected by several key design parameters, including the size/number of the subapertures and the number of training signals. Our results are verified by computer simulation and comparisons are made among various operating modes of the proposed TS-MIMO system. [J217]

"Signal Processing for Passive Radar Using OFDM Waveforms"

Passive radar is a concept where illuminators of opportunity are used in a multistatic radar setup. New digital signals, like digital audio/video broadcast (DAB/DVB), are excellent candidates for this scheme, as they are widely available, can be easily decoded to acquire the noise-free signal, and employ orthogonal frequency division multiplex (OFDM). Multicarrier transmission schemes like OFDM use block channel equalization in the frequency domain, efficiently implemented as a fast Fourier transform, and these channel estimates can directly be used to identify targets based on Fourier analysis across subsequent blocks. In this paper, we derive the exact matched filter formulation for passive radar using OFDM waveforms. We then show that the current approach using Fourier analysis across block channel estimates is equivalent to the matched filter, based on a piecewise constant assumption on the Doppler-induced phase rotation in the time domain. We next present high-resolution algorithms based on the same assumption: first we implement MUSIC as a 2-D spectral estimator using spatial smoothing; then we use the new concept of compressed sensing to identify targets. We compare the new algorithms and the current approach using numerical simulation and experimental data recorded from a DAB network in Germany. [J218]

"A Convolutional Learning System for Object Classification in 3-D Lidar Data"

In this brief, a convolutional learning system for classification of segmented objects represented in 3-D as point clouds of laser reflections is proposed. Several novelties are discussed: (1) extension of the existing convolutional neural network (CNN) framework to direct processing of 3-D data in a multiview setting which may be helpful for rotation-invariant consideration, (2) improvement of CNN training effectiveness by employing a stochastic meta-descent (SMD) method, and (3) combination of unsupervised and supervised training for enhanced performance of CNN. CNN performance is illustrated on a two-class data set of objects in a segmented outdoor environment. [J219]

"MIMO-OFDM radar for direction estimation"

Multiple-input-multiple-output (MIMO) radar makes use of orthogonal signals to obtain the phase delay for each transmitting/receiving antenna pair, and thus increasing the accuracy of direction estimation. The previously proposed MIMO radar assumes narrowband signals that guarantee the waveform orthogonality during the signals- transmission, propagation and reception. However, a narrowband system is unstable in target localisation because of the fluctuation of the target-s radar cross section. An MIMO-OFDM radar is proposed for target localisation. It adopts the OFDM technique to simultaneously transmit and receive a set of multiple narrowband orthogonal signals at orthogonal frequencies. A practical model accommodating a physical target is presented to simulate the MIMO-OFDM radar. As an example, a composite target composed of five infinite dielectric cylinders is localised by a four-element uniform linear array. The performance of the MIMO-OFDM radar is investigated by examining the estimation error for different numbers of sub-bands, different signal-to-noise ratios and different target directions. It is demonstrated by simulation that the MIMO-OFDM radar gives more statistically stable estimation by spreading the signal power over a wider spectrum. [J220]

"Motion feature extraction for stepped frequency radar based on Hough transform"

The high resolution range profile can be obtained through coherent pulse compression processing in every coherent processing interval (CPI) for stepped frequency radars (SFR). The radar observation time can be divided into multiple CPIs. By utilising the temporal information inherent to a sequence of these range profiles, a time-range image containing the target motion information can be synthesised. Through analyses of the point scatterer targets with the radial uniform motion, radial uniformly accelerated motion, rotation and vibration, this study indicates that there is a certain correlation between the target motion features and the time-range image features in the limited observation time. Based on this result, we propose a motion feature extraction method for SFR without any assistant information using the conventional and well-known feature extraction tool, Hough transform. The authors give detailed analyses and explanation of this method, and verify them by outfield experiments, demonstrate the motion feature extraction results using real radar data. The proposed method enables the motion feature extraction through space non-coherent integration, which fully utilises the radar data information under low signal-to-noise ratio conditions. [J221]

"ICESat Geolocation Validation Using Airborne Photography"

NASA's ICESat satellite launched in January of 2003, carrying the Geoscience Laser Altimeter. During the initial phase of this mission, many validation procedures were implemented to verify the accuracy associated with a variety of altimetry-derived data products. Of specific interest was the need to validate the geodetic position of the ICESat footprints, which is a convolution of laser-pointing determination, satellite position, and ranging measurements. This paper describes the methodology and implementation of one effort using aerial photography to image the laser spots on the surface during a satellite overflight. The spot locations are determined based on the relative positions of accurately placed geodetic infrared-emitting markers within the overflight area and apparent in the aerial photograph. One specific overflight opportunity captured six successive ICESat footprints with the airborne camera system. The mean geolocation predictions of those spots using the ground fiducial placement in the image provide a data product validation to better than 3.1-m rms on the surface with an estimated accuracy of ??3.6 m when compared to the ICESat solution. These results are within the ICESat mission requirement of 4.5 m on the surface (1.5-arcsecond pointing knowledge) for geodetic position determination. [J222]

"Performance analysis of ordered-statistic greatest of-constant false alarm rate with binary integration for M-sweeps"

The performance of the ordered-statistic greatest of (OSGO) constant false alarm rate (CFAR) scheme with binary integration for Mnon-coherent sweeps in Weibull background was investigated for homogeneous and non-homogeneous backgrounds, with an assumption of known shape parameter. This kind of processing is based on the fact that the clutter can be segmented in regions in many real radar scenarios where a time-varying two-parameter distribution function family can be fitted, but the clutter power may vary locally inside the region. Under the assumption of known shape parameter, the authors examined the changes of the false alarm rate and detection probability of the OSGO-CFAR with binary integration when the shape parameter differs from the nominal one, and compared them to those of the OSGO-CFAR with single pulse processing. The authors have derived analytic expressions of the detection probability and false alarm rate during clutter power transitions for the OSGO-CFAR with binary integration in Weibull background. It is shown that the OSGO-CFAR with binary integration can not only improve the detection performance significantly, but it also control the rise of the false alarm rate at clutter edges more effectively compared to the OSGO-CFAR with single pulse processing. Moreover, it exhibits a good immunity to the variation of the shape parameter. [J223]

"Problem of signal synchronisation in space-surface bistatic synthetic aperture radar based on

global navigation satellite emissions-experimental results"

This study presents the synchronisation problem in `space-surface bistatic synthetic aperture radar (SS-BSAR)` system. Global Navigation Satellite Systems (GNSS) are considered as transmitters of opportunity. It highlights various important issues of synchronisation, specifically related to SS-BSAR utilising GLONASS as the transmitter. Experimental testing of the synchronisation algorithm is described and verified using the GLONASS satellite. Also, experimental images obtained from GLONASS are presented and briefly analysed. [J224]

"An Analytical Approach for Performance Evaluation of Bit-Patterned Media Channels"

In this work, a new analytical approach is used to evaluate the error performance of bit-patterned media (BPM) magnetic recording channels that employ one-dimensional (1D) and two-dimensional (2D) generalized partial response (GPR) equalizers to combat the significant inter-track interference (ITI) expected in BPM magnetic recording systems. The probability density function of ITI is obtained analytically and is used to estimate the bit error rate (BER) from the Viterbi detector. The proposed method takes into account most of the important factors affecting the BER such as ITI, un-equalized intersymbol interference (ISI), colored noise and the distance and the multiplicity of error events. In this work, it is shown that for 1D channels, modeling ITI and un-equalized ISI by Gaussian PDFs leads to inaccurate BERs and that the non-Gaussian distribution of the ITI and un-equalized ISI must be taken into account for more accurate BER estimates. This method provides fast and accurate estimates of BERs for moderate to high signal-to-noise ratios (SNRs). By using this analytical method, time-consuming numerical simulations for error performance evaluation can be avoided. [J225]

"Acquisition of satellite navigation signals using dynamically chosen measurements"

A new approach to sequential acquisition of satellite navigation signals is presented where the collection of measurement statistics is steered dynamically during the acquisition process. The process consists of a fixed number of operation cycles during which the state of the receiver is maintained as a vector of conditional probabilities of acquisition hypotheses, each hypothesis being associated with a code delay and a Doppler frequency. During each operation cycle, one hypothesis is singled out by applying a suitable policy on the state vector. The down-converted satellite signal is then despread and frequency shifted according to the hypothesis. The resulting signal is integrated and squared to form a statistic that is used to update the state vector according to Bayes' theorem. After completing the cycles, a decision is made in favour of the hypothesis corresponding to the highest posterior probability. Two policies are investigated, one based on the maximisation of one-step posterior probability and the other based on the maximisation of information gain. Simulation results are presented indicating that the proposed approach provides a significant performance advantage over standard techniques for a wide range of signal-to-noise ratios. [J226]

"Experimental research of unsupervised Cameron/maximum-likelihood classification method for fully polarimetric synthetic aperture radar data"

In this study, experimental research on classification is applied to fully polarimetric data in X-band from China. Considering the amplitude and phase error between H and V channels in the system, the authors firstly correct the error in original data. The authors also deduce the formula of Cameron's classification method for the real data in our study. Then Cameron's method is used to initially classify the site image. Finally, the initial classification map defines training sets for the maximum-likelihood (ML) classifier. The advantages of this method are the automated classification and interpretation of each class based on the scattering mechanism. The experiment demonstrates the feasibility of the proposed approach, which dramatically improves the X-band data classification result compared with the Cameron method and H/Γ,Bï/MLmethod. [J227]

"Scaling the 3-D Image of Spinning Space Debris via Bistatic Inverse Synthetic Aperture Radar"

In 3-D inverse synthetic aperture radar (ISAR) imaging of spinning space debris, the image obtained via the available algorithm is modified by a scaling factor. Determined by the angle between the spinning vector and the radar line of sight, this factor cannot be estimated by a monostatic radar in a short imaging interval. This letter derives the bistatic ISAR (Bi-ISAR) geometry and signal model for 3-D imaging of space debris. Then, a 3-D image scaling algorithm is introduced based on the connections between the mono- and bistatic echoes of the same scatterer. Numeric simulations have proved the validity of the proposed algorithm. [J228]

"Switching off"

Researchers from Korea have developed a prototype of a high performance MEMS contact switch that could be used for a range of V and W-band communications and radar systems. Their design, which uniquely operates in a horizontal as well as a vertical direction, overcomes the problem of high-frequency signal transmission when

the switch is off; something that is inherent in other MEMS contact switch designs. [J229]

"High-resolution imaging of moving train by ground-based radar with compressive sensing"

A compressive sensing (CS) based method for ISAR imaging with a stepped-frequency chirp signal (SFCS) is presented. It is outlined that by using the CS technique, the data rate has been remarkably reduced in bandwidth synthesis processing for SFCS to achieve a high range resolution. Imaging results of a moving train demonstrate the effectiveness of the proposed method. [J230]

"+117 dbm high-efficiency CMOS power amplifiers operating at high voltage for 24 GHz radar sensor"

The authors investigated the series-bias technique suitable for designing complementary metal-oxide semiconductor (CMOS) power amplifiers using scaled-down CMOS technology. The series-bias technique effectively increased the operating voltage of two K-band amplifiers and achieved a high output power level. A two-stage series-bias amplifier showed a small signal gain of 9.5 dB, an output power of 17.7 dBm and a power-added efficiency (PAE) of 10.4 at 23 GHz. A three-stage series-bias amplifier showed a small signal gain of 17.3 dB, an output power of 17.5 dBm and a PAE of 8.8 at 23.5 GHz. The measured output power was the highest for K-band power amplifiers using common-source transistors. These amplifiers employing the series-bias technique are shown to have a highly favourable figure-of-merit compared with the results obtained from conventional amplifiers. The results will be useful for fully integrated radar sensors at microwave/millimetre-wave frequencies. [J231]

"SAR image edge detection using curvelet transform and Duda operator"

Edge detection plays a critical role in image reconstruction of remote imaging systems. To gain better quality detection, a novel method is proposed that combines the curvelet transform and Duda operator in a special fashion for processing synthetic aperture radar (SAR) images. To extract the coarse regions in the image, the curvelet transform is first applied to the image and then, after some processing, the Duda operator locates the edges precisely inside the regions. The superiority of the proposed method is demonstrated for Pi-SAR image data. [J232]

"Business Opportunities in the Military Sector [JMicrobusiness]"

Long before the momentous developments in cellular phones and the accompanying infrastructure, decades before microwave ovens were even dreamt of, microwaves were driven onward by the pressing military technology requirements of World War II. The 1940s saw a necessarily massive effort in largely tube-based microwave technology--with the Massachusetts Institute of Technology (MIT) in particular, famously driving research and development into new devices and techniques. [J233]

"Recently Published Books [JBook/Software Reviews]"

This listing is intended to bring to the attention of the readers a sample of some recently published books within the field of interest of IEEE Microwave Magazine. For information on submissions, contact the column editor at m.gupta@ieee.org. [J234]

"Costas CW frequency hopping radar waveform: peak sidelobe improvement using Golay complementary sequences"

The use of Golay complementary sequences to encode Costas frequency hopping continuous waveforms (CW) in order improve the range (time) sidelobe behaviour of received radar signals compared to classical techniques such as Barker coding is investigated for the first time. Sidelobe reduction is quantified using the aperiodic autocorrelation function and the periodic autocorrelation function. The results are compared with the same frequency hopping waveform encoded with a 13-bit Barker code. The results show that a 16 dB improvement in peak sidelobe performance is achieved over Barker coding using Golay complementary sequences with a code length of only 23and a 26 dB improvement with code length 28. [J235]

"Joint estimation of angle and Doppler frequency for bistatic MIMO radar"

A method of joint estimation of angle and frequency for bistatic multiple-input multiple-output (MIMO) radar based on ESPRIT using the rotational factor produced by time delay sampling is discussed. In this algorithm, transmit angles, receive angles and Doppler frequencies can be obtained simultaneously and automatically paired without array aperture loss. Simulation results confirm the effectiveness of the proposed method. [J236]

"Measurement of Ionospheric TEC in Spaceborne SAR Data"

The propagation of spaceborne radar signals operating at L-band frequency or below can be seriously affected by the ionosphere. At high states of solar activity, Faraday rotation (FR) and signal path delays disturb radar polarimetry and reduce resolution in range and azimuth. While these effects are negligible at X-band, FR and the frequency-dependent path delays can become seriously problematic starting at L-band. For quality assurance and calibration purposes, existing L-band or potential spaceborne P-band missions require the estimation of the ionospheric state before or during the data take. This paper introduces two approaches for measuring the ionospheric total electron content (TEC) from single-polarized spaceborne SAR data. The two methods are demonstrated using simulations. Both methods leverage knowledge of the frequency-dependent path delay through the ionosphere: The first estimates TEC from the phase error of the filter mismatch, while the second gauges path-delay differences between up and down chirps. FR, mean (direct current) offsets, and noise contributions are also considered in the simulations. Finally, possibilities for further methodological improvements are discussed. [J237]

"FDTD for Nanoscale and Optical Problems"

In this article, we have demonstrated that many representative problems of optical technologies can be accurately and effectively solved with the commercially available FDTD software, provided that such software offers the flexibility applying partial analytical knowledge to the problems. This is the case with scalar 2-D or guided 2-D FDTD algorithms relevant to the analysis of PhCs or microstructured optical fibers, as well as periodic FDTD method applicable in the scatterometry of ICs. We have also demonstrated an effective approach of hybridizing the FDTD and scalar Fresnel approaches for accurate and effective modeling of lens imaging phenomena. We believe that further developments along these lines using FDTD methods, supported by the concurrent developments in computer technology, will lead to hybrid time-domain software tools becoming a breakthrough in optics and photonics. [J238]

"Temperature-Dependable Microwave Dielectric Model for an Arctic Soil"

Dielectric measurements of an organic-rich permafrost soil over the range from 1.0 to 16 GHz and from -30??C to +25??C are presented. The measured shrub soil contains up to 90% organic matter and is the first soil of this composition for which the soil dielectric has been characterized. The measurements were fitted to the generalized refractive mixing dielectric model (GRMDM) recently proposed by Mironov et al., which combines the complex refractive indexes for the major components of the soil. These components were found to be the solid content, bound water, transient bound water, liquid capillary water, and moistened ice water. The dielectric properties of the frequency-dispersive components are each described by their own Debye relaxation spectrum. The GRMDM has been modified to incorporate the temperature dependence of the Debye parameters. The phase transformation of the soil water components at the freezing temperature is taken into account. As a result, a temperature-dependable GRMDM (TD GRMDM) has been developed, including model parameters which have a physical interpretation. This TD GRMDM predicts the dielectric for this soil in the whole range of moistures, frequencies, and temperatures measured. The model prediction errors are on the same order as that of dielectric measurements. The model proposed is the first of its kind to provide a physical basis for radar and radiothermal remote sensing algorithms that retrieve the freeze/thaw state and the volumetric moisture in the upper layer of an Arctic soil. [J239]

"Improvement of the Performance of a Helix Slow-Wave Structure With a Copper-Embedded Barrel"

The effect of a copper-embedded barrel on the performance of a helix slow-wave structure (SWS) has been studied theoretically and experimentally. The heat dissipation capability and cold-test characteristics of the SWSs with a monel barrel, a normal copper barrel, and a copper-embedded monel barrel have been analyzed and compared. With its combination of high mechanical strength and good thermal conductivity, the copper-embedded monel barrel enables better heat dissipation capability than the other barrel types and has low RF losses. [J240]

"Potentials and Limitations of Moon-Borne SAR Imaging"

Moon exploitation is among the next space mission priorities. Earth observation (EO), which is traditionally implemented on artificial lower Earth orbit satellites, can be, in principle, extended to the platform constituted by the natural Earth satellite. With this regard, we investigate the features related to the EO by a possible Moon-borne synthetic aperture radar system in terms of imaging characteristics and potential applications, as well as of expected limitations. [J241]

"Performance Study of a Cross-Frequency Detection Algorithm for Pulsed Sinusoidal RFI in Microwave Radiometry"

An analysis of the performance of a cross-frequency detection algorithm for pulsed sinusoidal radio frequency interference (RFI) is performed. The performance obtained is compared with that of pulse and kurtosis detection methods that have been previously reported. The results of the study show that the cross-frequency algorithm provides good performance in detecting pulsed sinusoidal RFI at high duty cycles, including the case of continuous sinusoidal interference. The use of the cross-frequency algorithm requires choice of a detection threshold that in practice can be estimated using measured data. The effect of this threshold estimation on the detector performance is also examined. [J242]

"A Novel Technique for Acquisition and Presentation of Complex Vibration Waveforms"

Oscilloscopes are traditionally used for the graphical presentation and analysis of electrical waveforms. In many experiments, waveform acquisition and live presentation forms the heart of the problem. In particular, data acquisition and presentation of repeating complex signals like sine sweep in vibration generation and testing and frequency-modulated signals in radar and sonar applications offers the challenge of live waveform presentation and their basic measurements. In this paper, we present a new, robust, fast, and simple technique for waveform period estimation in the time domain and oscilloscope triggering for both complex and simple waveforms. The proposed technique, namely, the normalized degree of difference (DOD), has both these capabilities, and it has been verified by extensive software simulations and implementation on the National Instruments (NI) LabVIEW-PXI platform. Successful real-time results are obtained for the sine sweep vibration waveform. The proposed technique, simulation, and implementation results are presented in this paper. [J243]

"Multiplicative Noise Removal Using Variable Splitting and Constrained Optimization"

Multiplicative noise (also known as speckle noise) models are central to the study of coherent imaging systems, such as synthetic aperture radar and sonar, and ultrasound and laser imaging. These models introduce two additional layers of difficulties with respect to the standard Gaussian additive noise scenario: (1) the noise is multiplied by (rather than added to) the original image; (2) the noise is not Gaussian, with Rayleigh and Gamma being commonly used densities. These two features of multiplicative noise models preclude the direct application of most state-of-the-art algorithms, which are designed for solving unconstrained optimization problems where the objective has two terms: a quadratic data term (log-likelihood), reflecting the additive and Gaussian nature of the noise, plus a convex (possibly nonsmooth) regularizer (e.g., a total variation or wavelet-based regularizer/prior). In this paper, we address these difficulties by: (1) converting the multiplicative model into an additive one by taking logarithms, as proposed by some other authors; (2) using variable splitting to obtain an equivalent constrained problem; and (3) dealing with this optimization problem using the augmented Lagrangian framework. A set of experiments shows that the proposed method, which we name MIDAL (multiplicative image denoising by augmented Lagrangian), yields state-of-the-art results both in terms of speed and denoising performance. [J244]

"Dual-Tree Complex Wavelet Transform Based SAR Despeckling Using Interscale Dependence"

In this paper, a dual-tree complex wavelet transform (DTCWT) based despeckling algorithm is proposed for synthetic aperture radar (SAR) images, considering the significant dependences of the wavelet coefficients across different scales. The DTCWT has the advantage of improved directional selectivity, approximate shift invariance, and perfect reconstruction over the discrete wavelet transform. The wavelet coefficients in each subband are modeled with a bivariate Cauchy probability density function (PDF) which takes into account the statistical dependence among the wavelet coefficients. Mellin transform of two dependent random variables is utilized to estimate the dispersion parameter of the bivariate Cauchy PDF from the noisy observations. This method is faster and effective when compared to that of the earlier techniques on numerical integration. Within this framework, we propose a new method for despeckling SAR images employing a maximum a posteriori estimator. Experimental results show that the proposed method based on bivariate Cauchy prior achieves better performance in terms of equivalent number of looks, peak signal-to-noise ratio, and Pratt's figure of merit. [J245]

"Modified Kirchhoff Migration for UWB MIMO Array-Based Radar Imaging"

In this paper, the formulation of Kirchhoff migration is modified for multiple-input-multiple-output (MIMO) array-based radar imaging in both free-space and subsurface scenarios. By applying the Kirchhoff integral to the multistatic data acquisition, the integral expression for the MIMO imaging is explicitly derived. Inclusion of the Snell's law and the Fresnel's equations into the integral formulation further expends the migration technique to subsurface imaging. A modification of the technique for strongly offset targets is proposed as well. The

developed migration techniques are able to perform imaging with arbitrary MIMO configurations, which allow further exploration of the benefits of various array topologies. The proposed algorithms are compared with conventional diffraction stack migration on free-space synthetic data and experimentally validated by ground-penetrating radar experiments in subsurface scenarios. The results show that the modified Kirchhoff migration is superior over the conventional diffraction stack migration in the aspects of resolution, side-lobe level, clutter rejection ratio, and the ability to reconstruct shapes of distributed targets. [J246]

"Corrections to “Signal Processing for Improved Detection of Trapped Victims Using UWB Radar” [JApr 10 2005-2014]"

In the above paper (this issue, pp. 2005-2014), there is an error in the top line of the right column, page 2010, which is corrected in this paper. [J247]

"Terrestrial Quadstatic Interferometric Radar Observations of Mars"

A new technique for resolving the ambiguity inherent in delay-Doppler radar observations of Mars has been developed and implemented using a suite of data collected during 2001, 2003, and 2005 oppositions. New recording systems, processing techniques, and, most importantly, the addition of a fourth receiving telescope allow for the high-resolution mapping of Mars' radar properties. In this paper, we develop a maximum likelihood method to probabilistically estimate the contributions to the received radar signal from the ambiguous resolution cells. Our delay-Doppler interferometric radar observations are designed to map the radar properties of Mars surface while disregarding the historically typical goal of measuring topography, instead using Mars' topography as a prioriknowledge. Example data from the September 27, 2003 observation over Mars' southern highlands, including Ma'adim Vallis and Gusev Crater, and the June 7, 2001 observation crossing Terra Meridiani are presented to demonstrate the effectiveness of the technique. Analysis of these observations predicted a root-mean-square (rms) roughness, or slopes, for the Mars Exploration Rover (MER) Spirit landing site of 1.80?? ?? 0.75??. Similarly, analysis of the Gusev Crater landing site of MER Opportunity predicted rms slopes of 1.1?? ? ? 0.1??. Both predictions were validated by analysis of in siturover images. [J248]

"Review on SAW RFID tags"

SAW tags were invented more than 30 years ago, but only today are the conditions united for mass application of this technology. The devices in the 2.4-GHz ISM band can be routinely produced with optical lithography, high-resolution radar systems can be built up using highly sophisticated, but low-cost RF-chips, and the Internet is available for global access to the tag databases. The "Internet of Things," or I-o-T, will demand trillions of cheap tags and sensors. The SAW tags can overcome semiconductor-based analogs in many aspects: they can be read at a distance of a few meters with readers radiating power levels 2 to 3 orders lower, they are cheap, and they can operate in robust environments. Passive SAW tags are easily combined with sensors. Even the "anti-collision" problem (i.e., the simultaneous reading of many nearby tags) has adequate solutions for many practical applications. In this paper, we discuss the state-of-the-art in the development of SAW tags. The design approaches will be reviewed and optimal tag designs, as well as encoding methods, will be demonstrated. We discuss ways to reduce the size and cost of these devices. A few practical examples of tags using a timeposition coding with 106 different codes will be demonstrated. Phase-coded devices can additionally increase the number of codes at the expense of a reduction of reading distance. We also discuss new and exciting perspectives of using ultra wide band (UWB) technology for SAW-tag systems. The wide frequency band available for this standard provides a great opportunity for SAW tags to be radically reduced in size to about 1 x 1 mm2while keeping a practically infinite number of possible different codes. Finally, the reader technology will be discussed, as well as detailed comparison made between SAW tags and IC-based semiconductor device. [J249]

"Noncoherent MIMO Radar for Location and Velocity Estimation: More Antennas Means Better Performance"

This paper presents an analysis of the joint estimation of target location and velocity using a multiple-input multiple-output (MIMO) radar employing noncoherent processing for a complex Gaussian extended target. A MIMO radar with Mtransmit and Nreceive antennas is considered. To provide insight, we focus on a simplified case first, assuming orthogonal waveforms, temporally and spatially white noise-plus-clutter, and independent reflection coefficients. Under these simplifying assumptions, the maximum-likelihood (ML) estimate is analyzed, and a theorem demonstrating the asymptotic consistency, large MN, of the ML estimate is provided. Numerical investigations, given later, indicate similar behavior for some reasonable cases violating the simplifying assumptions. In these initial investigations, we study unconstrained systems, in terms of complexity and energy, where each added transmit antenna employs a fixed energy so that the total transmitted energy is allowed to

increase as we increase the number of transmit antennas. Following this, we also look at constrained systems, where the total system energy and complexity are fixed. To approximate systems of fixed complexity in an abstract way, we restrict the total number of antennas employed to be fixed. Here, we show numerical examples which indicate a preference for receive antennas, similar to MIMO communications, but where systems with multiple transmit antennas yield the smallest possible mean-square error (MSE). The joint Cramer-Rao bound (CRB) is calculated and the MSE of the ML estimate is analyzed. It is shown for some specific numerical examples that the signal-to-clutter-plus-noise ratio (SCNR) threshold, indicating the SCNRs above which the MSE of the ML estimate is reasonably close to the CRB, can be lowered by increasing MN. The noncoherent MIMO radar ambiguity function (AF) is developed in two different ways and illustrated by examples. It is shown for some specif--ic examples that the size of the product MNcontrols the levels of the sidelobes of the AF. [J250]

"OFDM MIMO Radar With Mutual-Information Waveform Design for Low-Grazing Angle Tracking"

We propose an information theoretic waveform design algorithm for target tracking in a low-grazing angle (LGA) scenario. We incorporate realistic physical and statistical effects, such as Earth's curvature, vertical refractivity gradient of lower atmosphere, and compound-Gaussian characteristics of sea-clutter, into our model. We employ a co-located multiple-input-multiple-output (MIMO) radar configuration using wideband orthogonal frequency division multiplexing (OFDM) signalling scheme. The frequency diversity of OFDM provides richer information about the target as different scattering centers resonate at different frequencies. Additionally, we use polarization-sensitive transceivers to resolve the multipath signals with small separation angles. Thus, we track the scattering coefficients of the target at different frequencies along with its position and velocity. We apply a sequential Monte Carlo method (particle filter) to track the target. Our tracker works in a closed-loop fashion with an integrated optimal waveform design technique based on mutual information (MI) criterion. We seek the optimal OFDM waveform at the current pulse duration to maximize the MI between the state and measurement vectors at the next pulse duration utilizing all the measurement history up to the current pulse. Our numerical examples demonstrate the importance of realistic physical modeling, effects of frequency diversity through OFDM MIMO configuration, and achieved performance improvements due to adaptive OFDM waveform design. [J251]

"Validation of the ASAR Global Monitoring Mode Soil Moisture Product Using the NAFE'05 Data Set"

The Advanced Synthetic Aperture Radar (ASAR) Global Monitoring (GM) mode offers an opportunity for global soil moisture (SM) monitoring at much finer spatial resolution than that provided by the currently operational Advanced Microwave Scanning Radiometer for the Earth Observing System and future planned missions such as Soil Moisture and Ocean Salinity and Soil Moisture Active Passive. Considering the difficulties in modeling the complex soil-vegetation scattering mechanisms and the great need of ancillary data for microwave backscatter SM inversion, algorithms based on temporal change are currently the best method to examine SM variability. This paper evaluates the spatial sensitivity of the ASAR GM surface SM product derived using the temporal change detection methodology developed by the Vienna University of Technology. This evaluation is made for an area in southeastern Australia using data from the National Airborne Field Experiment 2005. The spatial evaluation is made using three different types of SM data (station, field, and airborne) across several different scales (1-25 km). Results confirmed the expected better agreement when using point (Rstation= 0.75) data as compared to spatial (RPLMR, 1 km= 0.4) data. While the aircraft-ASAR GM correlation values at 1-km resolution were low, they significantly improved when averaged to 5 km (RPLMR, 5 km= 0.67) or coarser. Consequently, this assessment shows the ASAR GM potential for monitoring SM when averaged to a spatial resolution of at least 5 km. [J252]

"Topographic Correction for ALOS PALSAR Interferometry"

L-band synthetic aperture radar (SAR) interferometry is very successful for mapping ground deformation in densely vegetated regions. However, due to its larger wavelength, the capacity to detect slow deformation over a short period of time is limited. Stacking and small baseline subset (SBAS) techniques are routinely used to produce time series of deformation and average deformation rates by reducing the contribution of topographic and atmospheric noise. For large sets of images that are presently available from C-band European Remote Sensing Satellites (ERS-1/2) and Environmental Satellite (ENVISAT), the standard stacking and SBAS algorithms are accurate. However, the same algorithms are often inaccurate when used for processing of interferograms from L-band Advanced Land Observing Satellite Phased Array type L-band SAR (ALOS PALSAR). This happens because only a limited number of interferograms is acquired and also because of large spatial baselines often correlated with the time of acquisition. In this paper two techniques are suggested that can be used for removing the residual topographic component from stacking and SBAS results, thereby increasing their accuracy. [J253]

"Estimation on Location, Velocity, and Acceleration With High Precision for Collision Avoidance"

An approach is proposed to estimate the location, velocity, and acceleration of a target vehicle to avoid a possible collision. Radial distance, velocity, and acceleration are extracted from the hybrid linear frequency modulation (LFM)/frequency-shift keying (FSK) echoed signals and then processed using the Kalman filter and the trilateration process. This approach proves to converge fast with good accuracy. Two other approaches, i.e., an extended Kalman filter (EKF) and a two-stage Kalman filter (TSKF), are used as benchmarks for comparison. Several scenarios of vehicle movement are also presented to demonstrate the effectiveness of this approach. [J254]

"A Channel Awareness Vehicle Detector"

State-of-the-art traffic-flow-detection technology includes the use of a looped vehicle detector, an infrared detector, an image detector, and a microwave detector. However, there are limitations that are associated with each detector. In this paper, we propose a channel awareness vehicle detector that can overcome these limitations. It employs only one pair of transmitter-receiver antennas to simultaneously perform the multilane and multivehicle identifications. By using the characteristics of channel variations, the proposed vehicle detector can determine the vehicle location, speed, and type. Our measurement results demonstrate its capabilities. [J255]

"Keeping Time with Maxwell's Equations"

Introducing a commercial FETD solver breaks new ground in EM field simulation. Based on the DGTD method, it allows unstructured geometry-conforming meshes to be used for the first time in transient EM field simulation. Since the underlying method doesn't require the solution of a large matrix equation, its computer memory usage is modest. Simulation speed is optimized without compromising accuracy or stability by introducing an innovative local timestepping procedure. In this procedure, small time steps are taken only where needed in small mesh elements while appropriately larger time steps are used in larger mesh elements. Furthermore, a local implicit time-stepping algorithm is employed with selected elements to further improve simulation speed. DGTD is a competitive alternative to traditional FDTD-based methods to solving Maxwell's equations in the time domain. The applications presented here include the electromagnetic pulse susceptibility of the differential lines in a laptop computer, the radar signature of a landmine under undulating ground,the TDR of a bent flex circuit, and the return loss of a connector. All of these examples involve complicated/ curved geometries where the flexibility of the unstructured meshes used in DGTD provides powerful advantages over simulation by conventional brickshaped FDTD and FIT meshes. [J256]

"Automatic target detection in simulated ground clutter (Weibull distributed) by multilayer perceptrons in a low-resolution coherent radar"

This study presents the problem of detecting known targets (Swerling 0 model) in simulated ground clutter (land cultivated). As a modelled low-resolution coherent radar system is used, the clutter is modelled by a complex-valued time-correlated Weibull distribution. The research exposed in this study looks for two objectives. First, finding a detection scheme that permits the final user (radar operator) determine if a target is present or not, and its position, size and shape. And second, designing a detection scheme as robust as possible against clutter and target condition changes and approximating the specification and measurement of the radar performance by using clutter models. However, these tasks are really complicated, because high-level clutter echoes are received. A detection scheme based on neural networks is proposed, where feedforward multilayer perceptrons are used. The performance obtained with this detection scheme is discussed from subjective (visual analysis of the achieved detection scans) and objective (receiver operating characteristics) points of view. Finally, this scheme is compared with a coherent detector commonly used when Weibull-distributed clutter is present, the target sequence known a priori detector. This comparison empirically demonstrates the performance improvement achieved by the proposed detector comparing with the commonly used. [J257]

"A CMOS Integrated Analog Pulse Compressor for MIMO Radar Applications"

Conventional radar pulse compressors use either surface acoustic wave devices or fast convolution processing, but both solutions have significant drawbacks. To overcome these drawbacks, an integrated analog pulse compressor for a multiple-input multiple-output (MIMO) radar has been developed with an 0.18-??m CMOS process using an arbitrary waveform generator, analog correlators, and analog-to-digital converters. The proposed scheme not only has advantages over conventional methods but also adds additional flexibility to the MIMO system. The die area is 5.67 mm2, and the power consumption is 62.6 mW from the 1.8-V supply. Arbitrary waveforms such as the wavelet and the chirp signal have been demonstrated, and the average signal-to-noise ratio for the pulse compression is 18.09 dB. The identification of overlapping multiple chirp signals is successfully demonstrated. [J258]

"Channel-Optimized Quantum Error Correction"

We develop a theory for finding quantum error correction (QEC) procedures which are optimized for given noise channels. Our theory accounts for uncertainties in the noise channel, against which our QEC procedures are robust. We demonstrate, via numerical examples, that our optimized QEC procedures always achieve a higher channel fidelity than the standard error correction method, which is agnostic about the specifics of the channel. This demonstrates the importance of channel characterization before QEC procedures are applied. Our main novel finding is that in the setting of a known noise channel the recovery ancillas are redundant for optimized quantum error correction. We show this using a general rank minimization heuristic and supporting numerical calculations. Therefore, one can further improve the fidelity by utilizing all the available ancillas in the encoding block. [J259]

"On the Hops Present in Costas Permutations"

Given that frequency-hopping filters cannot easily implement big frequency hops instantaneously, those Costas permutations are determined in which the maximal frequency hop prescribed is as small as possible, as well as those that do contain the maximal hop possible, and are, consequently, less suitable for applications. It turns out that exponential Welch permutations not only lead in general to the smallest hops, but are also relatively easy to study, as a closed formula exists for the maximal hop. Through extensive collection of data for logarithmic Welch and Golomb permutations, on the other hand, it is found that: a) these two families behave (almost) identically; and that b) their maximal hops do not get as small as in exponential Welch permutations. [J260]

"New Constructions of Binary Sequences With Optimal Autocorrelation Value/Magnitude"

In this paper, we give three new constructions of binary sequences of period AN with optimal autocorrelation value or optimal autocorrelation magnitude using N ГґB— 4 interleaved sequences. Yu and Gong recently found any binary sequence of period AN with optimal autocorrelation value constructed from an almost difference set by Arasu et al. is an N ГґB— 4 interleaved sequence for which all four columns in its N ГґB— 4 array are shift equivalent up to the complement. We found that it is not necessary that four columns are shift equivalent. Instead, it could be a pair of related sequences together with their shifts as the column sequences. The first construction is to use a generalized GMW sequence of period N = 2k- 1 and its modified version, the second construction is to use a twin prime sequence of length N = p(p + 2) and its modified version, and the third construction, a pair of Legendre sequences of period N = p (p odd prime) with their respective first terms complementary (the 2-level autocorrelation property is not needed for the Legendre sequence). The comparison with the known constructions are given. For the new sequences with optimal autocorrelation value, their corresponding new almost difference sets are also derived. [J261]

"Two-Dimensional Patterns With Distinct Differences-Constructions, Bounds, and Maximal Anticodes"

A two-dimensional (2-D) grid with dots is called a configuration with distinct differencesif any two lines which connect two dots are distinct either in their length or in their slope. These configurations are known to have many applications such as radar, sonar, physical alignment, and time-position synchronization. Rather than restricting dots to lie in a square or rectangle, as previously studied, we restrict the maximum distance between dots of the configuration; the motivation for this is a new application of such configurations to key distribution in wireless sensor networks. We consider configurations in the hexagonal grid as well as in the traditional square grid, with distances measured both in the Euclidean metric, and in the Manhattan or hexagonal metrics. We note that these configurations are confined inside maximal anticodes in the corresponding grid. We classify maximal anticodes for each diameter in each grid. We present upper bounds on the number of dots in a pattern with distinct differences contained in these maximal anticodes. Our bounds settle (in the negative) a question of Golomb and Taylor on the existence of honeycomb arrays of arbitrarily large size. We present constructions and lower bounds on the number of dots in configurations with distinct differences contained in various 2-D shapes (such as anticodes) by considering periodic configurations with distinct differences in the square grid. [J262]

"On the Role of Phase Stability in SAR Multibaseline Applications"

This paper is meant to present a statistical analysis of the role of propagation disturbances (PDs), such as those due to atmospheric disturbances or to residual platform motion, in multibaseline synthetic aperture radar (SAR) interferometry (InSAR) and tomography (T-SAR) applications. The analysis will consider both pointlike and distributed targets in such a way as to cover all the cases that are relevant in the applications. In order to provide a tool for the evaluation of the impact of PDs on the analysis of an arbitrary scenario, a definition of signal-to-noise ratio (SNR) will be introduced that accounts for both the presence of PDs and the characteristics

of the imaged scene. In the case of pointlike targets, it will be shown that such definition of SNR allows reusing well known results following after the Neyman-Pearson theory, thus providing a straightforward tool to asses phase-stability requirements for the detection and localization of multiple pointlike targets. In the case of distributed targets, instead, it will be provided a detailed analysis of the random fluctuations of the reconstructed scene as a function of the extent of the PDs, of the vertical structure of the imaged scene, and of the number of looks that are employed. Results from Monte Carlo simulations will be presented that fully support the theoretical developments within this paper. The most relevant conclusion of this paper is that the impact of PDs is more severe in the case where the imaged scene is characterized by a complex vertical structure or when multiple pointlike targets are present. As a consequence, it follows that the T-SAR analyses require either a higher phase stability or a more accurate phase calibration with respect to InSAR analyses. Finally, an example of phase-stability analysis and phase calibration of a real data set will be shown, based on a P-band data set relative to the forest site of Remningstorp, Sweden. [J263]

"Decorrelation of L-Band and C-Band Interferometry Over Vegetated Areas in California"

Temporal decorrelation is one of the main limitations for recovering interseismic deformation along the San Andreas Fault system using interferometric synthetic aperture radar. To assess the improved correlation properties of L-band with respect to C-band, we analyzed L-band Advanced Land Observation Satellite (ALOS) interferograms with a range of temporal and spatial baselines over three vegetated areas in California and compared them with corresponding C-band European Remote Sensing Satellite (ERS) interferograms. Over the highly vegetated Northern California forests in the Coast Range area, ALOS remains remarkably well correlated over a 2-year period, whereas an ERS interferogram with a similar temporal and spatial baseline lost correlation. In Central California near Parkfield, we found a similar pattern in decorrelation behavior, which enabled the recovery of a fault creep and a local uplifting signal at L-band that was not apparent at C-band. In the Imperial Valley in Southern California, both ALOS and ERS have low correlation over farmlands. ALOS has lower correlation over some sandy surfaces than ERS, probably due to low signal-to-noise ratio. In general, L-band interferograms with similar seasonal acquisitions have higher correlation than those with dissimilar season. For both L- and C-band, correlation over vegetated areas decreases with time for intervals less than 1 year and then remains relatively constant at longer time intervals. The decorrelation time for L-band is more than 2 years in the forest in California whereas that for C-band is less than 6 months. Overall, these results suggest that L-band interferograms will reveal near-fault interseismic deformation once sufficient data become available. [J264]

"Simulation of coherent sea clutter"

This study provides a brief overview of methods used to simulate sea clutter. It then offers a simple and flexible way of generating non-stationary coherent sea clutter that matches higher order statistics of real clutter in the time domain, as well as the shape and intensity distribution within the Doppler domain. Results confirm that the simulated signal intensity can also be well matched by the K-distribution. [J265]

"Accurate K-distributed clutter model for scanning radar application"

The correct formulation of the likelihood ratio test (LRT)-based detection schemes for a target in the presence of clutter needs a faithful and mathematically tractable clutter model. The state-of-art detection methods usually assume that the land and sea clutter in whose presence a target signal to be detected as K-distributed form of non-Gaussian clutter and uses an LRT detector obtained for the same. However, the macroscopic phenomena of clutter generation in a search radar and also the detailed studies on the measured clutter data show a significant texture fluctuation caused by the continuous antenna scanning motion. Incorporation of the scanning effect in the clutter model introduces challenges in modelling the varying texture and formulating a suitable detection scheme. Here the authors propose a clutter model for such scanning radar applications taking the effect of scanning on the clutter correlation into consideration. A method of fitting the proposed model to measured data and a method of simulating the clutter as per the proposed model are also presented. The proposed model is found to be attractive for an LRT detector design. Further in this study, the proposed clutter model is also validated through a real experimental data which show an excellent match between the simulated and measured data of both sea and land clutters. The close agreement between the model and the measurement clearly illustrates the validity and applicability of the model. [J266]

"An Impulse Response Function for Evaluation of UWB SAR Imaging"

Based on analysis of a point target imaged by different synthetic aperture radar (SAR) systems, the commonly used impulse response function in SAR Imaging (IRF-SAR)-a two-dimensional (2-D) sincfunction-is shown to be inappropriate for ultrawideband-ultrawidebeam (UWB) SAR systems utilizing a large fractional signal bandwidth and a wide antenna beamwidth. As a consequence, the applications of the 2-D sincfunction such as image

quality measurements and spatial resolution estimations are limited to narrowband-narrowbeam (NB) SAR systems exploiting a small fractional signal bandwidth and a narrow antenna beamwidth. In this paper, a more general IRF-SAR, which aims at UWB SAR systems, is derived with an assumption of flat two-dimensional (2-D) Fourier transform (FT) of a SAR image and called IRF-USAR. However, the derived IRF-USAR is also valid for NB SAR systems. [J267]

"GMTI clutter cancellation using real non-ideal data"

The performance of displaced phase centre antenna (DPCA), adaptive DPCA (ADPCA) and joint domain localised space time adaptive processing (JDL-STAP) was examined when applied to data that were not gathered for ground moving target indication (GMTI) purposes, and using very few array elements. Three different methods to be applied at the pre-processing stage to match pulses from different spatial channels were compared. The ADPCA method was shown to be the most robust in the presence of signals leaked from other range cells while traditional DPCA proved to be the most effective at attenuating stationary targets in non-ideal conditions, providing that pre-processing, using a pulse shift and a ramp in phase, was applied to the data. Quantitative results are presented, which are drawn from real experiments using real airborne radar data and which provide a valuable insight into the tolerance of DPCA, ADPCA and STAP when put to use with few spatial channels on non-ideal data. The study shows that all three GMTI algorithms used with few antenna elements can successfully resolve moving targets from clutter in such data and discusses the limitations of each in suppressing unwanted stationary peaks. [J268]

"Optimal Waveform Design for Improved Indoor Target Detection in Sensing Through-the-Wall Applications"

This paper deals with waveform design for improved detection and classification of targets behind walls and enclosed structures. The target impulse response is incorporated in an optimum design of the transmitted waveform which aims at maximizing the signal-to-interference and noise ratio (SINR) at the receiver output. The interference represents signal-dependent clutter which, along with the wall, degrades the receiver performance compared to the free-space and zero-clutter case. Computer simulations show sensitivity of the optimum waveform to target orientation but depict an SINR enhancement over chirped waveform radar emissions at all aspect angles. Numerical electromagnetic modeling is used to provide the impulse response of typical indoor stationary targets, namely, tables, chairs, and humans. [J269]

"Clutter modelling for space-time adaptive processing in airborne radar"

The presence of clutter can be highly detrimental to detection of targets in airborne radar systems. Space-time adaptive processing (STAP) attempts to alleviate the problem by exploiting angle-Doppler inter-relationships to suppress clutter. The requirements for modelling of clutter data that are suitable for the application of STAP are considered in this study. Examples of clutter generated using the ELMBAARC program in bistatic and monostatic applications are provided. Modelling of internal clutter motion is considered, together with its effect on the clutter domain in angle-Doppler space. Modelling of non-homogeneous clutter is also considered. [J270]

"Multiple scattering of HF surface waves: implications for radar design and sea clutter interpretation"

The interpretation of HF surface wave radar echoes is carried out, implicitly or explicitly, in the context of a physical model of the observation process on whose validity the verisimilitude of the interpretation depends. Hitherto it appears to have been near-universal practice to assume that the signal incident on any spatial cell being interrogated is a scaled, delayed version of the transmitted signal, arriving along the geodesic connecting the location of the transmitter with that of the cell. In this study, the authors describe a model that takes into account the changes to the radar signal as it propagates across the moving sea surface and show that the resulting redistribution of signal energy over the time delay, Doppler and direction-of-arrival dimensions can deviate markedly from that assumed by the idealised model. The authors investigate the dependence of the redistribution on radar and environmental parameters and provide what they hope will be useful guiding principles which can be employed to circumvent, or at least minimise, the short-comings of existing designs. [J271]

"Optimal Frequency-Hopping Sequences With New Parameters"

A frequency-hopping sequence (FHS) of length vand frequency set size Mis called a (v,M,Г,Вї)-FHS if its maximum out-of-phase Hamming autocorrelation is Г,Вї. Three new classes of optimal FHSs with respect to the Lempel-Greenberger bound are presented in this paper. First, new optimal (p,M,f)-FHSs are constructed when p = Mf +1 is an odd prime such that fis even and p Г,Вї 3 mod 4 . And then, a construction for optimal (kp,p,k)-

FHSs is given for any odd prime p and a positive integer K < p such that k = 2,4,p1,p1(p1+ 2),2m-1,or p1m-1, where p1and p1+2 are odd primes. Finally, several new optimal FHSs with maximum out-of-phase Hamming autocorrelation 1 or 2 are also presented. In particular, the existence of optimal (v,N,1)-FHSs is proven for any integer N Г‚Вї 3 and any integer v with N +1 Г‚Вї v Г‚Вї 2 N-1, as well as the existence of optimal (2N +1,N,2)-FHSs is shown for any integer N Г‚Вї 3. These classes of optimal FHSs have new parameters which are not covered in the literature. [J272]

"Design and Performance of a 24-GHz Switch-Antenna Array FMCW Radar System for Automotive Applications"

We develop a 24-GHz switch-antenna array frequency-modulated continuous-wave (FMCW) radar system composed of a single transmitter, a single transmitting antenna, four receiving antennas, a single-pole four-throw (SP4T) switch, and a single receiving channel. The antennas are integrated with radio-frequency (RF) and intermediate-frequency (IF) circuits to reduce the interconnection loss and realize a compact whole size. The receiving antennas are periodically switched to the single receiving channel. The performance of the developed system is evaluated using beamforming methods to estimate the angle, range, and velocity. [J273]

"Multihit mode direct-detection laser radar system using a Geiger-mode avalanche photodiode"

In this paper, a direct-detection laser radar system that uses a Geiger-mode avalanche photodiode (GAPD) of relatively short dead time (45 ns) is described. A passively Q-switched microchip laser is used as a laser source and a compact peripheral component interconnect system, which includes a time-to-digital converter (TDC), is set up for fast signal processing. With both the GAPD and the TDC functioning multistop acquisition, the system operates in a multihit mode. The software for the three-dimensional visualization and an algorithm for the removal of noise are developed. It is shown that the single-shot precision of the system is 10cm(sigma)and the precision is improved by increasing the number of laser pulses to be averaged so that the precision of 1cm(sigma)was acquired with more than 150 laser pulses scattered from the target. The accuracy of the system is measured to be 12 cm when the energy of the emitted laser pulse varies with a factor of 7. [J274]

"Estimation of Pulse Parameters by Autoconvolution and Least Squares"

Let the parameter vector of a baseband pulse be Г‚Вї=[D, A, W]T, where D=arrival time, A=amplitude, and W=width. A method for estimating Г‚Вї for a pulse present in a noisy data segment is given. We start by performing an autoconvolution (AC) of the data segment, and then recording the shift where the AC peaks. By taking half of that shift, from the end of the segment, a point is placed near the middle of the pulse. Next, we partition the pulse at that point and perform two more ACs, (one on the left half of the pulse and another on the right half), and find two more shifts where the ACs peak. These two shifts provide coarse measurements on D and W. A further refinement by least squares (LS) then produces a final estimate for Г‚Вї. Simulation results have corroborated the theoretical development and shown that the new estimator performs close to the Cramer-Rao lower bound (CRLB). [J275]

"Frequency Estimation by Phase Unwrapping"

Single frequency estimation is a long-studied problem with application domains including radar, sonar, telecommunications, astronomy and medicine. One method of estimation, called phase unwrapping, attempts to estimate the frequency by performing linear regression on the phase of the received signal. This procedure is complicated by the fact that the received phase is `wrapped' modulo and therefore must be `unwrapped' before the regression can be performed. In this paper, we propose an estimator that performs phase unwrapping in the least squares sense. The estimator is shown to be strongly consistent and its asymptotic distribution is derived. We then show that the problem of computing the least squares phase unwrapping is related to a problem in algorithmic number theory known as the nearest lattice point problem. We derive a polynomial time algorithm that computes the least squares estimator. The results of various simulations are described for different values of sample size and SNR. [J276]

"Single-Range Image Fusion for Spinning Space Debris Radar Imaging"

In this letter, a novel single-range image fusion method for radar imaging of spinning space debris with dimensions smaller than the radar range resolution is proposed. On the assumption that the target consists of isolated isotropic scattering centers, a 2-D image can be obtained using single-range unit cross-range echo data, which have a theoretical resolution of a quarter of a wavelength. The proposed approach is computationally efficient particularly for smaller sized targets, as the total rotational angle is divided into four small sections, allowing for easier processing of each region. Moreover, the proposed method can be used to directly obtain an image in Cartesian coordinates, unlike current algorithms where images are obtained in a polar

format, requiring reformatting to the Cartesian grid. The validity of the proposed approach is confirmed using numerical simulations. [J277]

"Representation and Generation of Non-Gaussian Wide-Sense Stationary Random Processes With Arbitrary PSDs and a Class of PDFs"

A new method for representing and generating realizations of a wide-sense stationary non-Gaussian random process is described. The representation allows one to independently specify the power spectral density and the first-order probability density function of the random process. The only proviso is that the probability density function must be symmetric and infinitely divisible. The method proposed models the sinusoidal component frequencies as random variables, a key departure from the usual representation a of wide-sense stationary random process by the spectral theorem. Ergodicity in the mean and autocorrelation is also proven, under certain conditions. An example is given to illustrate its application to the K distribution, which is important in many physical modeling problems in radar and sonar. [J278]

"Joint Detection Estimation Problem of Monopulse Angle Measurement"

Estimation of the direction of arrival (DOA) of a signal source by means of a monopulse estimation scheme is one of the oldest and most widely used high-precision techniques in operational tracking systems. Although the statistical performance of this estimation technique has been extensively investigated, it has never been analyzed from the viewpoint of the joint detection-estimation problem. As a consequence the historical form of the (detector-angle estimator) solution has become the usual form implemented in operational tracking systems and may restrict their accessible performance. Indeed, the application of the optimal detection theory reveals alternative (detector-angle estimator) solutions providing other relevant trade-offs in detection-estimation performances that are worth considering to optimize the performance of the tracking system according to the scenario. Both stochastic signal model (Rayleigh-type signal source) and deterministic signal model (signal source of unknown amplitude) have been investigated, leading to a novel but equally simple (detector-angle estimator) solution through which analytical statistical prediction has been derived. Comparison of detection-estimation performances of new and usual solutions is presented. [J279]

"Sequential Track Initialization with Page's Test"

A new track initialization method for remote sensing systems that uses the amplitudes of the measurements to provide some statistical separation between true and false contacts is presented. In the proposed method the data are partitioned into Hough transform bins, and Page's test is performed on the data in each bin. The new method embodies the best ideas of existing sequential and batch methods, exploits both the amplitude and the temporal information in the data, and minimizes the average latency for initializing target tracks for a specified false track initialization rate. Analytic performance predictions for the proposed method for the Swerling I signal model with Poisson clutter are developed and compared with the theoretical performance of a commonly used "M of N" method. The new method provides substantial improvement in the false track initialization rate and the average latency for initializing target tracks. [J280]

"Dimensionality Reduction Techniques for Efficient Adaptive Pulse Compression"

Adaptive filtering for radar pulse compression has been shown to improve sidelobe suppression through the estimation of an appropriate pulse compression filter for each individual range cell of interest. However, the relatively high computational cost of full-dimension, adaptive range processing may limit practical implementation in many current real-time systems. Dimensionality reduction techniques are here employed to approximate the framework for pulse compression filter estimation. Within this approximate framework, two new minimum mean square error (MMSE) based adaptive algorithms are derived. The two algorithms are denoted as specific embodiments of the fast adaptive pulse compression (FAPC) method and are shown to maintain performance close to that of full-dimension adaptive processing, while reducing computation cost by nearly an order of magnitude (in terms of the discretized waveform length N). [J281]

"A Polarimetric Target Detector Using the Huynen Fork"

The contribution of synthetic aperture radar polarimetry in target detection is described and found to add valuable information. A new target detection methodology that makes novel use of the polarization fork of the target is described. The detector is based on a correlation procedure in the target space, and other target representations (e.g., Huynen parameters or ?? angle) can be employed. The mathematical formulation is general and can be applied to any kind of single target; however, in this paper, the detection is optimized for the odd and even bounces (the first two elements of the Pauli scattering vector) and for the oriented dipoles.

Validation against real data shows significant agreement with the expected results based on the theoretical description. [J282]

"The Importance of Soil Moisture and Soil Structure for InSAR Phase and Backscatter, as Determined by FDTD Modeling"

In this paper, we introduce a finite-difference time-domain simulator that accurately models the interaction of microwaves with realistic soils, specifically from spaceborne interferometric synthetic aperture radar (InSAR). The modeled soils are characterized by surface roughness, correlation length, bulk moisture content, vertical moisture gradient, and small air-filled-void content. Simulation results include both backscatter and interferometric phase, and we are particularly interested in assessing the potential of the latter as a proxy for soil moisture. We find that differences in homogeneous bulk moisture result in only small phase differences (< 5?). In contrast, combinations of vertical moisture gradients and small air-filled voids, which may typically exist in more realistic soils, can produce phase changes > 30? for HH and > 50? for VV when the soil moisture is varied from 3% to 30% in the uppermost 2 cm of the soil. Phase changes of this magnitude are easily detectable by spaceborne InSAR techniques. While a strong phase response to a change in mean bulk moisture is common to vertical moisture gradient and small air-filled-void cases, their corresponding backscatter responses are very different. A vertical moisture gradient makes the backscatter response dramatically flatter compared with the case of uniform moisture; in contrast, the introduction of air-filled voids barely alters the backscatter. Thus, it may be possible to infer near-surface soil-structure parameters such as vertical gradients or fractions of voids and inhomogeneities from combined SAR phase and backscatter data. Future SAR sensors could be optimized for this purpose. Prior theoretical work based on the assumption of vertically uniform soil-moisture distributions may need to be adjusted, and the lack of a theory that accommodates more complex soil structures may explain why backscatter inversions have yet to result in a viable operational system. [J283]

"Physical Meaning of Bistatic Polarimetric Parameters"

A generalization of the polarization theory to bistatic scattering had shown that coherent scattering mechanisms are characterized by six bistatic fork parameters. The purpose of this paper is to try again to assign physical properties to these parameters as it was done in the monostatic case by Huynen. Our conclusions are validated with COSMO (Coherent Scattering Model) model and BABI (Base BIstatique) measurements. [J284]

"Coseismic Horizontal Offsets and Fault-Trace Mapping Using Phase Correlation of IRS Satellite Images: The 1999 Izmit (Turkey) Earthquake"

On August 17, 1999, a strong earthquake (Mw ?? 7.4) occurred along the western sector of the North Anatolian Fault system in Turkey. The epicenter was located near the city of Izmit, 50 km east of Istanbul. Previous works determined the coseismic surface displacements by satellite synthetic aperture radar (SAR) interferometry (InSAR) and satellite optical-image correlation. In 1999, the highest spatial resolution orbiting camera was the panchromatic sensor (PAN), a 5.8-m pixel sensor (SPOT 2 was a 10-m pixel sensor) onboard the Indian Remote Sensing (IRS) satellite. We propose to apply a new phase-correlation method to PAN images to study the coseismic rupture due to the Izmit earthquake. The phase-correlation method does not need phase unwrapping and was proved to be robust under a wide variety of circumstances. Image correlometry deals with the quantification of the subpixel offsets over the whole image, allowing displacement measurement with an accuracy that is proportional to the pixel size. We measured the near-field deformations exploiting two geometrically corrected IRS images with similar look angles. A quality check of the derived offset map was performed by comparison with GPS benchmarks and SPOT offsets. The results show that IRS PAN images can be correlated to derive coseismic slip offsets due to a large earthquake (and to map its fault trace). [J285]

"Knowledge-Aided Bayesian Radar Detectors & Their Application to Live Data"

This paper considers the problem of adaptive radar detection in Gaussian clutter with unknown spectral properties. We employ a Bayesian approach based on a suitable model for the probability density function (pdf) of the unknown clutter covariance matrix. We devise two detectors based on the generalized likelihood ratio test (GLRT) criterion both one-step and two-step. The suggested decision rules achieve the same performance as the non-Bayesian GLRT detectors when the size of the training set is sufficiently large. However, our new detectors significantly outperform their non-Bayesian counterparts when the training set is small. The analysis is also supported by results on real L-band clutter data from the MIT Lincoln Laboratory phase one radar and on high fidelity radar data from the knowledge-aided sensor signal processing and expert reasoning (KASSPER) program. [J286]

"Generalised Covariance Union: A Unified Approach to Hypothesis Merging in Tracking"

Multi-hypothesis tracking (MHT) techniques can become prohibitively computationally expensive as the number of hypotheses increases. In order to maintain an estimate with bounded computational cost, multi-hypothesis methods often merge the estimates together. When the hypotheses are distributed according to a known probability then standard mixture reduction (SMR) methods exist for merging estimates. Also, covariance union (CU) has become a popular approach to merging hypotheses when their distribution is not known. This paper generalises CU to a new theory, which we refer to as generalised covariance union (GCU). GCU merges estimates when their distribution is not known precisely but is, instead, bounded above and below. We show that CU and the SMR approaches are limiting cases of GCU. We demonstrate the efficacy of the new approach via a Global Positioning System (GPS) tracking application with time delayed satellite signals. [J287]

"Empirical Evaluation of Wireless Localization when Using Multiple Antennas"

We show that signal strength variability can be reduced by employing multiple low-cost antennas at fixed locations. We further explore the impact of this reduction on wireless localization by analyzing a representative set of algorithms ranging from fingerprint matching, to statistical maximum likelihood estimation, to threshold bounding of signal fingerprints, and to multilateration. Using an indoor wireless testbed, we provide experimental evaluation of the localization performance under multiple antennas. We found that in nearly all cases the performance of localization algorithms improved when using multiple antennas. Specifically, the median and the 90th percentile error can be reduced up to 70 percent. Additionally, we found that multiple antennas improve the localization stability significantly, up to 100 percent improvement, when there are small-scale three-dimensional movements of a mobile device around a given location. [J288]

"Altitude Measurement Based on Beam Split and Frequency Diversity in VHF Radar"

A new beam split altitude interferometry based on altitude diversity and frequency diversity for very high frequency (VHF) radar is proposed in this paper. As opposed to microwave radar, VHF radar has a wide beam which is usually split when ground reflection occurs. The reflected wave which is coherent with the direct wave will always be contained in the target echo. In this paper, several antennas of different heights are utilized. Owing to the certain relationship among the phases of the split beams, the elevation region where the targets are located can be determined using the phases of echoes. Using "amplitude-comparison" of echoes from various antennas to get the normalized error signals, the elevation of the target can be obtained by looking it up in the error signal table. The effect of roughness on the altitude measurement accuracy is also analyzed. The real data processing on flat and slope terrains testifies to the validity of the proposed method. The altitude measurement precision, especially in low-elevation regions, is greatly improved by using frequency diversity. [J289]

"Source Localization and Sensing: A Nonparametric Iterative Adaptive Approach Based on Weighted Least Squares"

Array processing is widely used in sensing applications for estimating the locations and waveforms of the sources in a given field. In the absence of a large number of snapshots, which is the case in numerous practical applications, such as underwater array processing, it becomes challenging to estimate the source parameters accurately. This paper presents a nonparametric and hyperparameter, free-weighted, least squares-based iterative adaptive approach for amplitude and phase estimation (IAA-APES) in array processing. IAA-APES can work well with few snapshots (even one), uncorrelated, partially correlated, and coherent sources, and arbitrary array geometries. IAA-APES is extended to give sparse results via a model-order selection tool, the Bayesian information criterion (BIC). Moreover, it is shown that further improvements in resolution and accuracy can be achieved by applying the parametric relaxation-based cyclic approach (RELAX) to refine the IAA-APES&BIC estimates if desired. IAA-APES can also be applied to active sensing applications, including single-input single-output (SISO) radar/sonar range-Doppler imaging and multi-input single-output (MISO) channel estimation for communications. Simulation results are presented to evaluate the performance of IAA-APES for all of these applications, and IAA-APES is shown to outperform a number of existing approaches. [J290]

"Context-Dependent Multisensor Fusion and Its Application to Land Mine Detection"

We present a novel method for fusing the results of multiple land mine detection algorithms which use different sensors, features, and different classification methods. The proposed multisensor/multialgorithm fusion method, which is called context-dependent fusion (CDF), is motivated by the fact that the relative performance of different sensors and algorithms can vary significantly depending on the mine type, geographical site, soil and weather conditions, and burial depth. CDF is a local approach that adapts the fusion method to different regions of the feature space. The training part of CDF has two components: context extraction and algorithm fusion. In context extraction, the features used by the different algorithms are combined and used to partition the feature space into

groups of similar signatures, or contexts. The algorithm fusion component assigns a degree of worthiness to each detector in each context based on its relative performance within the context. To test a new alarm using CDF, each detection algorithm extracts its set of features and assigns a confidence value. Then, the features are used to identify the best context, and the degrees of worthiness of this context are used to fuse the individual confidence values. Results on large and diverse ground-penetrating radar and wideband electromagnetic data collections show that the proposed method can identify meaningful and coherent clusters and that different expert algorithms can be identified for the different contexts. Typically, the contexts correspond to groups of alarm signatures that share a subset of common features. Our extensive experiments have also indicated that CDF outperforms all individual detectors and the global fusion that uses the same method to assign aggregation weights. [J291]

"Enhancement of Coupled Multichannel Images Using Sparsity Constraints"

We consider the problem of joint enhancement of multichannel images with pixel based constraints on the multichannel data. Previous work by Cetin and Karl introduced nonquadratic regularization methods for SAR image enhancement using sparsity enforcing penalty terms. We formulate an optimization problem that jointly enhances complex-valued multichannel images while preserving the cross-channel information, which we include as constraints tying the multichannel images together. We pose this problem as a joint optimization problem with constraints. We first reformulate it as an equivalent (unconstrained) dual problem and develop a numerically-efficient method for solving it. We develop the Dual Descent method, which has low complexity, for solving the joint optimization problem. The algorithm is applied to both an interferometric synthetic aperture radar (IFSAR) problem, in which the relative phase between two complex-valued images indicate height, and to a synthetic multimodal medical image example. [J292]

"Phased-MIMO Radar: A Tradeoff Between Phased-Array and MIMO Radars"

We propose a new technique for multiple-input multiple-output (MIMO) radar with colocated antennas which we call phased-MIMO radar. The new technique enjoys the advantages of the MIMO radar without sacrificing the main advantage of the phased-array radar which is the coherent processing gain at the transmitting side. The essence of the proposed technique is to partition the transmit array into a number of subarrays that are allowed to overlap. Then, each subarray is used to coherently transmit a waveform which is orthogonal to the waveforms transmitted by other subarrays. Coherent processing gain can be achieved by designing a weight vector for each subarray to form a beam towards a certain direction in space. Moreover, the subarrays are combined jointly to form a MIMO radar resulting in higher angular resolution capabilities. Substantial improvements offered by the proposed phased-MIMO radar technique as compared to the phased-array and MIMO radar techniques are demonstrated analytically and by simulations through analyzing the corresponding beam patterns and the achievable output signal-to-noise-plus-interference ratios. Both analytical and simulation results validate the effectiveness of the proposed phased-MIMO radar. [J293]

"SAR and Multispectral Image Fusion Using Generalized IHS Transform Based on a Trous Wavelet and EMD Decompositions"

In the intensity hue saturation (IHS) based image fusion, the enhancement of the spatial information often leads to the distortion of the information in the spectral domain. In this paper, a spectral preserve fusion method is developed by introducing aГ‚Bï trous wavelet transform (AWT) and empirical mode decomposition (EMD) into one generalized IHS transform, which extends panchromatic sharpening of low-resolution multispectral images (LRMIs) through detail injection to the fusion of LRMIs and synthetic aperture radar imagery (SARI). The original LRMIs are first transformed into one low-resolution intensity component (LRIC) and the details from the SARI are abstracted using AWT. The LRIC and the approximation image of the SARI are fused through an intrinsic mode functions based model. Subsequently, high RIC produced through an inverse AWT is then substituted for the old one. High RMIs are obtained through an inverse IHS transform. Experiments reveal that this approach performs better than the AWT and IHS-AWT-based methods in preserving the spectral information of the LRMIs. The performance of the image fusion is examined both visually and quantitatively. [J294]

"A Double Inequality for the Equivalent Impulse Bandwidth"

In this paper, we derive a double inequality that permits one to obtain a lower and an upper limit for the value of the impulse bandwidth of a measuring receiver. The limits are the reciprocal of the integral of the relative envelope of the impulse response (lower limit) and the integral of the relative frequency response (upper limit) of the intermediate frequency (IF) filter. Since the limits are relative quantities, their evaluation does not require the use of a calibrated generator, the only significant sources of error being receiver's vertical scale nonlinearity and noise proximity. Here, the deviation between the impulse bandwidth and its limits is quantified for practical IF

filter configurations. The dominant contributions to measurement uncertainty are identified and suggestions for reducing their magnitude are also offered. [J295]

"Sparse Array 3-D ISAR Imaging Based on Maximum Likelihood Estimation and CLEAN Technique"

Large 2-D sparse array provides high angular resolution microwave images but artifacts are also induced by the high sidelobes of the beam pattern, thus, limiting its dynamic range. CLEAN technique has been used in the literature to extract strong scatterers for use in subsequent signal cancellation (artifacts removal). However, the performance of DFT parameters estimation based CLEAN algorithm for the estimation of the signal amplitudes is known to be poor, and this affects the signal cancellation. In this paper, DFT is used only to provide the initial estimates, and the maximum likelihood parameters estimation method with steepest descent implementation is then used to improve the precision of the calculated scatterers positions and amplitudes. Time domain information is also used to reduce the sidelobe levels. As a result, clear, artifact-free images could be obtained. The effects of multiple reflections and rotation speed estimation error are also discussed. The proposed method has been verified using numerical simulations and it has been shown to be effective. [J296]

"Cold Regions Hydrology High-Resolution Observatory for Snow and Cold Land Processes"

Snow is a critical component of the global water cycle and climate system, and a major source of water supply in many parts of the world. There is a lack of spatially distributed information on the accumulation of snow on land surfaces, glaciers, lake ice, and sea ice. Satellite missions for systematic and global snow observations will be essential to improve the representation of the cryosphere in climate models and to advance the knowledge and prediction of the water cycle variability and changes that depend on snow and ice resources. This paper describes the scientific drivers and technical approach of the proposed Cold Regions Hydrology High-Resolution Observatory (CoReH2O) satellite mission for snow and cold land processes. The sensor is a synthetic aperture radar operating at 17.2 and 9.6 GHz, VV and VH polarizations. The dual-frequency and dual-polarization design enables the decomposition of the scattering signal for retrieving snow mass and other physical properties of snow and ice. [J297]

"A 77 GHz 90 nm CMOS Transceiver for FMCW Radar Applications"

The first 77 GHz frequency modulated continuous wave (FMCW) radar transceiver IC with an accurate FMCW chirp signal generator using a 90 nm CMOS process is presented. To realize accurate FMCW radar system in CMOS, a PLL synthesizer based FMCW generator with chirp smoothing technique that is able to output linear FMCW frequency chirp using a nonlinear reference chirp signal supplied from a low spec/cost digital-oriented frequency reference is applied. The fabricated IC consists of an LNA, a down-conversion mixer with an output buffer, a driver amplifier, a power amplifier with power combiner, an LO distributer and an FMCW synthesizer. The measured FMCW signal from the proposed FMCW generator achieves 93 kHz frequency error (nonlinearity) at the 77 GHz chip signal. Radar performance of the IC has less than 1% ranging error from 1 m to 8 m distance from the measurement in a laboratory. These results show the transceiver achieves a fundamental function for radar applications with 520 mW power consumptions. [J298]

"Compressed Synthetic Aperture Radar"

In this paper, we introduce a new synthetic aperture radar (SAR) imaging modality which can provide a high-resolution map of the spatial distribution of targets and terrain using a significantly reduced number of needed transmitted and/or received electromagnetic waveforms. This new imaging scheme, requires no new hardware components and allows the aperture to be compressed. It also presents many new applications and advantages which include strong resistance to countermesasures and interception, imaging much wider swaths and reduced on-board storage requirements. [J299]

"Dual-Polarization C-Band Radar Observations of Sea Ice in the Amundsen Gulf"

Polarimetric observations of sea ice from synthetic aperture radar can, in principle, assist in sea-ice classification and ice-water discrimination. In this paper, we use dual-polarization ground-based scatterometer observations of sea ice to assess the potential value of spaceborne dual-polarization observations of sea ice for operational ice analysis, focusing on C-band and, in particular, the contribution of the HV backscatter coefficient and HH/VV polarization ratios. Results show that signature variability resulting from frost flowers, ice deformation, and snow cover can overwhelm systematic differences between younger ice types, up to first-year thin. As a result of this and noise floor limitations of spaceborne sensors, the HV backscatter coefficient makes visual ice type and open water discrimination easier only below about 30?? incidence angle. The HH/VV ratio is less impacted by the noise floor of spaceborne sensors but retains similar ambiguities for sea-ice classification. [J300]

"MST Radar Signal Processing Using Cepstral Thresholding"

The cepstrum thresholding approach for variance reduction is applied to estimate the spectrum of mesosphere-stratosphere-troposphere radar data, which are complex. Unlike in a real data case, where the cepstral values are real, for complex signals, cepstral values will be complex. We propose two different thresholding approaches: 1) applying a threshold independently for real and imaginary values of cepstral estimates and 2) threshold application to the modulus of cepstral estimates. Reductions of the total variance of the estimated spectra using the aforementioned two threshold approaches have been tested with simulated data. Finally, the algorithm has been applied to the practical atmospheric radar data to estimate the wind parameters through the computation of Doppler shift. Results have been validated using simultaneous Global Positioning System sonde data. [J301]

"Evaluation of Ozone Analyses From UARS MLS Assimilation by BASCOE Between 1992 and 1997"

We present the analyses of UARS MLS ozone data obtained by the Belgian Assimilation System for Chemical ObsErvations (BASCOE). This system, based on the 4D-var method, is dedicated to the assimilation of stratospheric chemistry observations. It uses a 3-D Chemical Transport Model (3D-CTM) including 57 chemical species with explicit calculation of stratospheric chemistry. The CTM is driven by ECMWF ERA-40 analyses of winds and temperature, with a horizontal grid of 3.75 in latitude by 5 in longitude, and with 37 pressure levels from the surface to 0.1 hPa. BASCOE has assimilated UARS MLS observations acquired during the period 1992-1997. We discuss how BASCOE is able to reproduce MLS data, and we evaluate the BASCOE analyses with respect to independent observations from UARS HALOE, ozonesondes, and ground-based lidars. An excellent agreement is found with independent observations (bias usually less than 10%), except in the lowermost stratosphere and in the Antarctic ozone hole. The performances of BASCOE ozone analyses are also compared to those of two other long-term ozone reanalyses; namely, ERA-40 and ERA-Interim, both from ECMWF. Finally, sensitivity test based on BASCOE free model runs suggest that ozone analyses during the ozone hole period would be greatly improved by driving BASCOE with the dynamical fields of the new ECMWF reanalyses ERA-Interim. This work is part of the Stratospheric Ozone Profile Record service raised by the GMES Service Element PROMOTE. [J302]

"Single-Pass Bistatic SAR Interferometry Using Fixed-Receiver Configurations: Theory and Experimental Validation"

In this paper, bistatic interferometry using fixed-receiver configurations is addressed both theoretically and experimentally. The analytical expressions for interferometric phase and height sensitivity are derived, and a full interferometric processing chain for digital elevation model (DEM) generation is presented. The derived expressions are general, and they can be applied to two possible acquisition geometries: backscatteringand forward scattering. The theoretical developments are complemented with experimental results done with the bistatic receiver Synthetic Aperture radar Bistatic Receiver for INterferometric Applications. The obtained DEMs are compared with a DEM from the Shuttle Radar Topography Mission and a digital terrain model from the Institut Cartografic de Catalunya. The comparison allows one to validate the results and demonstrate to which particular features of the scene that the bistatic radar is sensitive. [J303]

"Kalman Filtering in Wireless Sensor Networks"

Challenges associated with the scarcity of bandwidth and power in wireless communications have to be addressed. For the state-estimation problems discussed in the paper, observations about a common state are collected by physically distributed terminals. To perform state estimation, wireless sensor networks (WSNs) may share these observations with each other or communicate them to a fusion center for centralized processing. With K vector observations {yk(n)}Kk=1available, the optimal mean squared error (MSE) estimation of the state x(n) for the linear model is accomplished by a Kalman filter. [J304]

"Three-Component Model-Based Decomposition for Polarimetric SAR Data"

An improved three-component decomposition for polarimetric synthetic aperture radar (SAR) data is proposed in this paper. The reasons for the emergence of negative powers in the Freeman decomposition have been analyzed, and three corresponding improvements are included in the proposed method. First, the deorientation process is applied to the coherency matrix before it is decomposed into three scattering components. Then, the coherency matrix with the maximal polarimetric entropy, i.e., the unit matrix, is used as the new volume-scattering model instead of the original one adopted in the Freeman decomposition. A power constraint is also added to the proposed three-component decomposition. The E-SAR polarimetric data acquired over the

Oberpfaffenhofen area in Germany are applied in the experiment. The results show that the pixels with negative powers are totally eliminated by the proposed decomposition, demonstrating the effectiveness of the new model. [J305]

"Definition of ICESat Selection Criteria for Their Use as Height References for TanDEM-X"

The TanDEM-X satellite synthetic aperture radar (SAR) mission, which is the result of the partnership between the German Aerospace Center (DLR) and Astrium GmbH, has the goal to deliver a high-precision global digital elevation model (DEM). The X-band SAR interferometry-derived DEMs contain absolute and relative height errors that have to be minimized with the help of height references in order to achieve the specified accuracies. ICESat laser altimetry data are suited for this task, due to their accuracy and global distribution. In order to gain experience in the comparison between a radar-derived DEM and ICESat GLA14 elevation data, an X-band DEM was acquired over a test region with the experimental airborne radar system of DLR in Oberpfaffenhofen. Additionally, a laser DEM of the area was used to verify the height accuracy claimed by previously published ICESat studies over different terrain types and after applying different selection threshold criteria. The analyses described in this paper are the basis for the definition of a suitable global ICESat selection strategy and include the computation of the density of selected ICESat samples over the Earth. These aspects are crucial for a successful TanDEM-X DEM generation. [J306]

"Outdoor Propagation Channel Modeling in Foliage Environment"

Foliage is a rich scattering environment that is slowly time varying. Most previous investigations in foliage models center on the statistical modeling of clutters and targets. Ideally, it would be desirable to characterize the nature of the propagation channel in foliage; however, it has not been investigated in detail up until now. This paper studies the problem of nonline-of-sight (NLOS) channel modeling based on extensive data collected using both narrowband and ultrawideband (UWB) radars. The modeling adopts the CLEAN algorithm, in which the channel-impulse response (CIR) is accomplished. It is observed that the multipath contributions arriving at the receiver are grouped into clusters. The arrival of clusters can be modeled as a Poisson process, whereas within each cluster, subsequent multipath contributions or rays also arrive according to a Poisson process. However, the arrival rate is quite different, along with the carrier frequency. It is also proposed that the amplitude of multipath channels can more accurately be characterized by a log-logistic distribution (LLD) other than commonly used clutter models such as the log-normal, the Weibull, or the Rayleigh fading model. The proposed foliage channel model is extendable to other outdoor environments. This is a great advantage for the specification and development of future wireless systems. [J307]

"Instrument-Based Noncontact Doppler Radar Vital Sign Detection System Using Heterodyne Digital Quadrature Demodulation Architecture"

In this paper, we present a fast solution to build a Doppler radar system for noncontact vital sign detection (VSD) using instruments that are generally equipped in radio-frequency and communication laboratories. This paper demonstrates the feasibility of conducting research on VSD in ordinary radio-frequency laboratories. The system is designed with a heterodyne digital quadrature demodulation architecture that helps mitigate quadrature channel imbalance and eliminate the complicated dc offset calibration required for arctangent demodulation. Moreover, its tunable carrier frequency helps select different optimal frequencies for different human objects. Two sets of extensive experiments have been carried out in the laboratory environment with a self-designed 2.4-GHz patch antenna array and a 1-18-GHz broadband antenna. The test results are satisfactory: for a 0-dBm transmit power, the detection range can be extended to 2.5 m with accuracy higher than 80%. The system is also capable of detecting vital signs in the presence of different obstructions between the subject and the antenna. [J308]

"UWB Through-Wall Imaging Based on Compressive Sensing"

To achieve high-resolution 2-D images, through-wall imaging (TWI) radar with ultra-wideband and long antenna arrays faces considerable technical challenges such as a prolonged data collection time, a huge amount of data, and a high hardware complexity. This paper presents a novel data acquisition scheme and an imaging algorithm for TWI radar based on compressive sensing (CS), which states that a signal having a sparse representation can be reconstructed from a small number of nonadaptive randomized projections by solving a tractable convex program. Instead of measuring all spatial-frequency data, a few samples, by employing an overcomplete dictionary, are sufficient to obtain reliable target space images even at high noise levels. Preliminary simulated and experimental results show that the proposed algorithm outperforms the conventional delay-and-sum beamforming method even though many fewer CS measurements are used. [J309]

"TerraSAR-X Commissioning Phase Execution Summary"

This paper provides an overview of the TerraSAR-X commissioning phase (CP). The overall CP planning and preparation is presented. The strategy for data-take (DT) command generation is discussed, and statistical reports summarize the acquired CP DTs. An overview summary on the main results in the different characterization and verification areas is provided together with synthetic aperture radar image examples. [J310]

"Flood Detection in Urban Areas Using TerraSAR-X"

Flooding is a major hazard in both rural and urban areas worldwide, but it is in urban areas that the impacts are most severe. An investigation of the ability of high-resolution TerraSAR-X synthetic aperture radar (SAR) data to detect flooded regions in urban areas is described. The study uses a TerraSAR-X image of a one-in-150-year flood near Tewkesbury, U.K., in 2007, for which contemporaneous aerial photography exists for validation. The German Aerospace Center (DLR) SAR end-to-end simulator (SETES) was used in conjunction with airborne scanning laser altimetry (LiDAR) data to estimate regions of the image in which water would not be visible due to shadow or layover caused by buildings and taller vegetation. A semiautomatic algorithm for the detection of floodwater in urban areas is described, together with its validation using aerial photographs. Of the urban water pixels that are visible to TerraSAR-X, 76% were correctly detected, with an associated false positive rate of 25%. If all the urban water pixels were considered, including those in shadow and layover regions, these figures fell to 58% and 19%, respectively. The algorithm is aimed at producing urban flood extents with which to calibrate and validate urban flood inundation models, and these findings indicate that TerraSAR-X is capable of providing useful data for this purpose. [J311]

"Predictive Iterated Kalman Filter for INS/GPS Integration and Its Application to SAR Motion Compensation"

This paper deals with the problem of state estimation for the integration of an inertial navigation system (INS) and Global Positioning System (GPS). For a nonlinear system that has the model error and white Gaussian noise, a predictive filter (PF) is used to estimate the model error, and based on this, a modified iterated extended Kalman filter (IEKF) is proposed and is called predictive iterated Kalman filter (PIKF). The basic idea of the PIKF is to compensate the state estimate by the estimated model error. An INS/GPS integration system is implemented using the PIKF and applied to synthetic aperture radar (SAR) motion compensation. Through flight tests, it is shown that the PIKF has an obvious accuracy advantage over the IEKF and unscented Kalman filter (UKF) in velocity. [J312]

"Analysis of Local Variation of Soil Surface Parameters With TerraSAR-X Radar Data Over Bare Agricultural Fields"

The objective of this paper is to analyze the sensitivity of very high resolution TerraSAR-X radar data taken over bare soils to surface soil parameters and to study the spatial variability of these parameters at a fine scale (within a field plot). The relationship between the backscattering coefficient and the soil's parameters (moisture, surface roughness, texture, and local topography) was examined by means of four satellite images, as well as ground truth measurements, of each of the three agricultural plots, recorded during several field campaigns in the winter and spring of 2008. TerraSAR images demonstrate high potential for the identification of local variations of roughness and texture. An approach for the estimation of local moisture is proposed using an empirical method adapted to the scale of an individual field. The results show that, by using TerraSAR-X data to study bare agricultural fields, local variations in soil moisture can be retrieved with a root-mean-square error of 0.05 cm3??cm-3. [J313]

"Efficient Wavenumber Domain Focusing for Ground-Based SAR"

We present an efficient focusing algorithm for synthetic aperture radar (SAR) data acquired in short bursts by a geometry with a large range spread, i.e., the case of ground-based (GB) SAR. The usual approach for focusing GB SAR data is the polar formatting algorithm, whose computational complexity, however, is quite relevant due to the nonseparability of the kernel. In this letter, we introduce a different format for the focused data, namely, the range-angular domain. Such format keeps the benefit of the polar format that samples data close to the resolution, but allows for the design of a separable kernel in the wavenumber domain. The proposed kernel exploits a modified Stolt interpolation and an efficient space-varying resampling. Results of processing on both simulated and real data are presented. [J314]

"Field Investigations of Ku-Band Radar Penetration Into Snow Cover on Antarctic Sea Ice"

Monitoring long-term, large-scale changes in the Antarctic sea ice thickness is not currently possible due to the sampling constraints of the ship-based and airborne observations which comprise most of the available thickness data. Satellite radar altimetry has been used to measure sea ice thickness variability in the Arctic where it is assumed that the highest amplitude radar return originates from the snow/ice interface as the Arctic snow is cold and dry; however, this may not be the case in the Antarctic due to more complex snow stratigraphy caused by warmer winter temperatures and frequent snow flooding. We present the first measurements of radar penetration into snow cover on Antarctic sea ice in the Ku-band at which satellite radar altimeters operate. Data were taken using a sled-borne radar on sea ice off East Antarctica during September and October 2007. Radar data and field measurements of snow density, thickness, wetness, and layers were taken over a range of locations including snow packs with flooding, hard crusts, and icy layers. Detailed snow pit studies showed that the snow/ice interface was the dominant scattering surface only for snow without morphological features or flooding. Analysis of transect data showed that the mean depth of the dominant scattering surface of the radar was only around 50% of the mean measured snow depth, indicating that the dominant scattering surface was not always the snow/ice interface for the Antarctic sea ice surveyed. [J315]

"TerraSAR-X System Performance Characterization and Verification"

This paper presents results from the synthetic aperture radar (SAR) system performance characterization, optimization, and verification as carried out during the TerraSAR-X commissioning phase. Starting from the acquisition geometry and instrument performance, fundamental acquisition parameters such as elevation beam definition, range timing, receiving gain, and block adaptive quantization setting are presented. The verification of the key performance parameters-ambiguities, impulse-response function, noise, and radiometric resolution-is discussed. ScanSAR and Spotlight particularities are described. [J316]

"TOPS Imaging With TerraSAR-X: Mode Design and Performance Analysis"

This paper reports about the performed investigations for the implementation of the wide-swath TOPS (Terrain Observation by Progressive Scan) imaging mode with TerraSAR-X (TSX). The TOPS mode overcomes the limitations imposed by the ScanSAR mode by steering the antenna along track during the acquisition of a burst. In this way, all targets are illuminated with the complete azimuth antenna pattern, and, thus, scalloping is circumvented, and an azimuth dependence of signal-to-noise ratio and distributed target ambiguity ratio (DTAR) is avoided. However, the use of electronically steered antennas leads to a quantization of the steering law and a nonideal pattern for squinted angles (grating lobes and main lobe reduction). The former provokes spurious peaks, while the latter introduces slight scalloping and DTAR deterioration. These effects are analyzed and quantified for TSX, and a TOPS system design approach is presented. Next, the requirements concerning interferometry are investigated. Finally, several results are shown with the TSX data, including a comparison between the TOPS and the ScanSAR modes and the reporting of the first TOPS interferometric results. [J317]

"Radio Frequency Tomography for Tunnel Detection"

Radio frequency (RF) tomography is proposed to detect underground voids, such as tunnels or caches, over relatively wide areas of regard. The RF tomography approach requires a set of low-cost transmitters and receivers arbitrarily deployed on the surface of the ground or slightly buried. Using the principles of inverse scattering and diffraction tomography, a simplified theory for below-ground imaging is developed. In this paper, the principles and motivations in support of RF tomography are introduced. Furthermore, several inversion schemes based on arbitrarily deployed sensors are devised. Then, limitations to performance and system considerations are discussed. Finally, the effectiveness of RF tomography is demonstrated by presenting images reconstructed via the processing of synthetic data. [J318]

"Focusing Bistatic SAR Data in Airborne/Stationary Configuration"

This paper presents a frequency-domain-based focusing algorithm for the bistatic synthetic aperture radar (BiSAR) data in airborne/stationary configuration. In this bistatic configuration, only the moving platform contributes to the azimuth modulation, whereas the stationary platform introduces a range offset (RO) to the range migration trajectories of targets at the same range. The offset is determined by the azimuth position of different targets with respect to the stationary platform. Since the RO is position dependent, monostatic SAR imaging algorithms are not able to focus the bistatic data collected in this configuration. In this paper, an analytical bistatic point-target reference spectrum is derived, and then, a frequency-domain-based algorithm is developed to focus the bistatic data. It uses an interpolation-free wavenumber-domain algorithm as a basis and performs a range-variant interpolation to correct the position-dependent RO in the image domain after coarse focusing. The proposed algorithm is validated by the simulated data and the real BiSAR data acquired by the Forschungsgesellschaft fu??r Angewandte Naturwissenschaften's airborne SAR system, PAMIR, in December

2007. In this BiSAR experiment, an X-band transmitter was stationary operated on a hill with PAMIR as the receiver mounted on a Transall C-160. [J319]

"Unifying Experiment Design and Convex Regularization Techniques for Enhanced Imaging With Uncertain Remote Sensing Data-Part I: Theory"

This paper considers the problem of high-resolution remote sensing (RS) of the environment formalized in the terms of a nonlinear ill-posed inverse problem of estimation of the power spatial spectrum pattern (SSP) of the wavefield scattered from an extended remotely sensed scene via processing the discrete measurements of a finite number of independent realizations of the observed degraded data signals [single realization of the trajectory signal in the case of synthetic aperture radar (SAR)]. We address a new descriptive experiment design regularization (DEDR) approach to treat the SSP reconstruction problem in the uncertain RS environment that unifies the paradigms of maximum likelihood nonparametric spectral estimation, descriptive experiment design, and worst case statistical performance optimization-based regularization. Pursuing such an approach, we establish a family of the DEDR-related SSP estimators that encompass a manifold of algorithms ranging from the traditional matched filter to the modified robust adaptive spatial filtering and minimum variance beamforming methods. The theoretical study is resumed with the development of a fixed-point iterative DEDR technique that incorporates the regularizing projections onto convex solution sets into the SSP reconstruction procedures to enforce the robustness and convergence. For the imaging SAR application, the proposed DEDR approach is aimed at performing, in a single optimized processing, adaptive SAR focusing, speckle reduction and RS scene image enhancement, and accounts for the possible presence of uncertain trajectory deviations. [J320]

"Unifying Experiment Design and Convex Regularization Techniques for Enhanced Imaging With Uncertain Remote Sensing Data-Part II: Adaptive Implementation and Performance Issues"

The unified descriptive experiment design regularization (DEDR) method from a companion paper provides a rigorous theoretical formalism for robust estimation of the power spatial spectrum pattern of the wavefield scattered from an extended scene observed in the uncertain remote sensing (RS) environment. For the considered here imaging synthetic aperture radar (SAR) application, the proposed DEDR approach is aimed at performing, in a single optimized processing, SAR focusing, speckle reduction, and RS scene image enhancement and accounts for the possible presence of uncertain trajectory deviations. Being nonlinear and solution dependent, the optimal DEDR estimator requires rather complex signal processing operations ruled by the fixed-point iterative implementation process. To simplify further the processing, in this paper, we propose to incorporate the descriptive regularization via constructing the projections onto convex sets that enable us to factorize and parallelize the reconstructive image processing over the range and azimuth coordinates, design a family of such regularized easy-to-implement iterative algorithms, and provide the relevant computational recipes for their application to fractional imaging SAR. We also comment on the adaptive adjustment of the DEDR operational parameters directly from the actual speckle-corrupted scene images and demonstrate the effectiveness of the proposed adaptive DEDR techniques. [J321]

"Processing of Sliding Spotlight and TOPS SAR Data Using Baseband Azimuth Scaling"

This paper presents an efficient phase preserving processor for the focusing of data acquired in sliding spotlight and Terrain Observation by Progressive Scans (TOPS) imaging modes. They share in common a linear variation of the Doppler centroid along the azimuth dimension, which is due to a steering of the antenna (either mechanically or electronically) throughout the data take. Existing approaches for the azimuth processing can become inefficient due to the additional processing to overcome the folding in the focused domain. In this paper, a new azimuth scaling approach is presented to perform the azimuth processing, whose kernel is exactly the same for sliding spotlight and TOPS modes. The possibility to use the proposed approach to process data acquired in the ScanSAR mode, as well as a discussion concerning staring spotlight, is also included. Simulations with point targets and real data acquired by TerraSAR-X in sliding spotlight and TOPS modes are used to validate the developed algorithm. [J322]

"Climatology of the Aerosol Extinction-to-Backscatter Ratio from Sun-Photometric Measurements"

The elastic lidar equation contains two unknown atmospheric parameters, namely, the particulate optical extinction and backscatter coefficients, which are related through the lidar ratio (i.e., the particulate-extinction-to-backscatter ratio). So far, independent inversion of the lidar signal has been carried out by means of Raman lidars (usually limited to nighttime measurements), high-spectral-resolution lidars, or scanning elastic lidars under the assumption of a homogeneously vertically stratified atmosphere. In this paper, we present a procedure to obtain the lidar ratio at 532 nm by a combined Sun-photometer-aerosol-model inversion, where the viability of the solution is largely reinforced by assimilating categorized air-mass back-trajectory information. Thus, iterative

lidar-ratio tuning to reconstruct the Sun-photometric aerosol optical depth (AOD) is additionally constrained by the air-mass back trajectories provided by the hybrid single-particle Lagrangian integrated-trajectory model. The retrieved lidar ratios are validated with inversions of lidar data based on the Klett-Fernald-Sasano algorithm and with the Aerosol Robotic Network (AERONET)-retrieved lidar ratios. The estimated lidar ratios concur with the AERONET-retrieved lidar ratios and with those of the well-known KFS inversion constrained with Sun-photometric AOD values and embedded single-scattering models. The proposed method can be applied to routinely extract climatological values of the lidar ratio using measurements of direct solar irradiance (more numerous than those of sky radiance). [J323]

"On the Doppler Spreading Effect for the Range-Instantaneous-Doppler Technique in Inverse Synthetic Aperture Radar Imagery"

Inverse synthetic aperture radar (ISAR) is an all-weather radar technique which may generate high-resolution images of noncooperative targets. The standard range-Doppler algorithm (RDA) is usually employed for image generation. However, the images obtained with RDA are usually blurred because of the relative motion between radar and target. As a consequence, motion compensation techniques should be used to improve the imagery quality. The range-instantaneous-Doppler (RID) technique based on time-frequency transforms has been proposed for obtaining a sequence of focused ISAR images without the need of using motion compensation techniques. However, in this letter, it is clearly shown that the migration of the target scatterers in slant range indirectly induces Doppler spreading of the scatterers' point spread function in each of the ISAR images obtained by the RID technique. This Doppler spreading means blurring. It is important to highlight that the migration in slant range may be caused not only by the radial component of the translational motion but also by the rotational motion. The application of motion compensation techniques prior to the use of the RID technique allows us to mitigate the Doppler spreading, as shown here both for simulated and live data acquired by a high-resolution coherent radar. [J324]

"MIMO Radar Waveform Design via Alternating Projection"

Waveform design is essential to unleash the performance advantages promised by multiple-input multiple-output (MIMO) radar, and this topic has attracted a lot of attention in the recent years. Revisiting an earlier examined MIMO radar waveform design problem that optimizes both minimum mean-square error estimation (MMSE) and mutual information (MI), in this correspondence we formulate a new waveform design problem and provide some further results, which complement the previous study. More specifically, we present an iterative optimization algorithm based on the alternating projection method to determine waveform solutions that can simultaneously satisfy a structure constraint and optimize the design criteria. Numerical examples are provided, which illustrate the effectiveness of the proposed approach. In particular, we find that the waveform solutions obtained through our proposed algorithm can achieve very close and virtually indistinguishable performance from that predicted in the previous study. [J325]

"A New Slant-Range Velocity Ambiguity Resolving Approach of Fast Moving Targets for SAR System"

This paper describes an ambiguity resolving approach for slant-range velocity estimation which utilizes the wideband characteristic of the transmitted signal (multiple wavelengths). Based on the wavelength dual-wavelength radar data. Then, two effective approaches are introduced to focus the moving target no matter the Doppler ambiguity exists or not. The slant-range velocity is estimated by the number of azimuth cell displacements between the two focused images. Both imaging methods have different properties and advantages. A performance analysis is made, and deleterious factors in practice are analyzed in detail. The effectiveness of the unambiguous slant-range velocity estimation approach is demonstrated with the use of simulated and real data. [J326]

"The TerraSAR-X Ground Segment"

TerraSAR-X, the first national German remote-sensing satellite, was launched on June 15, 2007. It carries an X-band high-resolution synthetic aperture radar (SAR) instrument featuring imaging modes like StripMap, ScanSAR, and, particularly, SpotLight in a variety of different polarization modes. Primary mission goal is the provision of both science and commercial users with a variety of products from advanced SAR modes. The TerraSAR-X Ground Segment, which is provided by the German Aerospace Center (DLR), constitutes the central element for controlling and operating the TerraSAR-X satellite, for calibrating its SAR instrument, and for archiving the SAR data, as well as generating and distributing the basic data products. This paper depicts the ground-segment layout and describes its major elements. The ordering and product-generation workflow is presented. It introduces the applied prelaunch integration, testing, verification, and validation approach, a major

key to the completion not only of the SAR technical-verification program but also the operational qualification of the ground segment itself within the commissioning phase. [J327]

"Segmentation of ISAR Images of Targets Moving in Formation"

This paper proposes a new method to separate inverse synthetic aperture radar (ISAR) images using the range-Doppler algorithm when multiple targets fly closely spaced in a formation. This method is composed of three steps. The first step is an initial range-Doppler imaging of the whole set of targets to obtain a ??bulk?? image. In this step, range profiles are aligned using a new cost function, which is the sum of the amplitudes of the pixels lying along a polynomial that models the trajectory of the bulk image. To reduce the probability of incorrectly aligning high-amplitude pixels from different targets, pixel amplitudes are converted to binary form: A number ?? of pixels with the greatest amplitudes are identified in the bulk range profile, and their amplitudes are converted to one; the amplitudes of the remaining pixels are converted to zero. This process gives each of the ?? pixels the same weight on the cost function. Then, phase adjustment is used to coarsely separate targets in a 2-D image. The second step is the separation of the bulk image into component images using a window of the target size. The third step is a second range-Doppler imaging, in which each ISAR image is enhanced using range alignment and phase adjustment. Simulations using three targets composed of point scattering centers prove that the proposed method can effectively segment three targets flying in a formation. [J328]

"ISAR Imaging of Maneuvering Target Based on the L-Class of Fourth-Order Complex-Lag PWVD"

In inverse synthetic aperture radar (ISAR) imaging of a maneuvering target, the received signal in a range bin can be characterized as a multicomponent polynomial phase signal (PPS) after motion compensation. The traditional discrete Fourier transform algorithm is not appropriate in analyzing the PPS. In this paper, the L-class of a fourth-order complex-lag polynomial Wigner-Ville distribution (PWVD) is presented to generate a high-resolution time-frequency distribution (TFD) for the multicomponent PPS. For a signal with polynomial phase up to order four (this is accurate enough in ISAR imaging), the cross-terms between different components can be reduced by the convolution in the frequency domain of the L-class of the fourth-order complex-lag PWVD. The new TFD is used in the ISAR imaging of the maneuvering target, and high-quality instantaneous ISAR images are obtained. Results of simulated and real data demonstrate the effectiveness of the method above. [J329]

"Scattering Model for a Pine Tree Employing VIE With a Broadband MLFMA and Comparison to ICA"

In this paper, we present accurate calculations of electromagnetic wave scattering from a high-detail pine tree model, which includes also the needles. We have deployed a volume integral equation (VIE) model, which takes into account high-order reflections between all scatterers, even between single needles. The pine tree is modeled as a realistic collection of dielectric cylinders. With the help of our calculations, we assess the importance of multiple scattering inside the pine canopy and the contribution of the needles to the scattering. We compare our calculations with a much simpler model output to determine the validity conditions for simplified approaches. As the simpler model, we use an infinite cylinder approximation (ICA) model which uses a truncated cylinder approximation and takes into account only the first-order reflections from single cylinders. Both models are bistatic, fully coherent, and fully polarimetric models suitable in calculating the scattering from a large and general collection of dielectric cylinders. Our results show that, for the C-band calculations, the VIE model output differs significantly from the simple ICA model output, indicating the importance of the higher order scattering between the needles and branches. However, for the L-band, the accurate VIE model gives similar results as the ICA model, indicating that, in this case, the higher order scattering between the needles can be neglected. [J330]

"Forest Modeling For Height Inversion Using Single-Baseline InSAR/Pol-InSAR Data"

The Random Volume over Ground (RVoG) model has been extensively applied to polarimetric synthetic aperture radar interferometry (Pol-InSAR) data for forest height inversion. The model assumes forest as a homogeneous volume of randomly oriented particles characterized by a constant extinction but does not take into account the forest vertical heterogeneity, to which interferometric coherence is sensitive. In order to integrate vertical heterogeneity in forest models, two complementary models, which take into consideration the forest natural structure, are investigated through analysis of volume interferometric coherence. The first model assumes a vertically varying extinction in the volume layer, and the second model considers predominant contributions localized in a finite height interval, modeled as a Gaussian-distributed backscatter. The two forest models are compared with constant extinction RVoG in the coherence and interferometric phase aspects. Finally, the contribution of these new models for forest height inversion using the Pol-InSAR technique is discussed in the context of a two-layer ground + canopy medium. [J331]

"Nonuniform Ground Motion Monitoring With TerraSAR-X Persistent Scatterer Interferometry"

In the past, the application of Persistent Scatterer Interferometry (PSI) was primarily possible in the case of slow (less than a few centimeters per year) uniform movements. In this paper, we show how PSI permits the monitoring of relatively fast (including rates up to > 50 cm/year) and nonuniform movements using TerraSAR-X repeat observations over deep-level mining. To enable this, parts of the PSI methodology were adapted to the special characteristics of the example studied. Apart from a description of the methodology used and the result achieved, error considerations and a validation of the result with in situ measurements are included. [J332]

"Mapping of Different Sea Ice Regimes Using Images From Sentinel-1 and ALOS Synthetic Aperture Radar"

Airborne C- and L-band synthetic aperture radar (SAR) images were acquired for three test sites over different sea ice regimes around Svalbard in March 2007, complemented by optical imagery, environmental data, and ice observations. One objective was to use the high-resolution low-noise radar data for investigations on the technical performance of European Space Agency's Sentinel-1 mission for sea ice mapping, the other to assess the potential gain of additional use of L-band SAR data currently available from Advanced Land Observing Satellite (ALOS). The airborne SAR images were employed to simulate data products resembling the interferometric wide-swath mode (IWSM) of Sentinel-1 and ALOS PALSAR fine resolution mode (FRM) in order to quantify the information loss due to the higher noise level and coarser spatial resolution. At the IWSM noise level, zones of deformation, level ice, and new ice can be well separated at like-polarization. At cross-polarization, the noise level is too high for a robust automated classification including thin ice, but deformed and level ice can be discriminated. PALSAR FRM is on average better suited to distinguish deformed and level ice over all ice regimes. It was worse for separating new from thicker level ice at two test sites. For the third test site with very few patches of new ice, the PALSAR FRM showed larger intensity contrasts between new and level ice than Sentinel-1 IWSM. The spatial resolution provided by the IWSM and FRM is sufficient to identify most ice features and types without ambiguities. Typical characteristics of the imaged ice regimes are described. [J333]

"A Bistatic SAR Raw Data Simulator Based on Inverse Algorithm"

A synthetic aperture radar (SAR) raw data simulator is an important tool for testing the system parameters and the imaging algorithms. In this paper, a scene raw data simulator based on an inverse ω-kalgorithm for bistatic SAR of a translational invariant case is proposed. The differences between simulations of monostatic and bistatic SAR are also described. The algorithm proposed has high precision and can be used in long-baseline configuration and for single-pass interferometry. Implementation details are described, and plenty of simulation results are provided to validate the algorithm. [J334]

"Segmentation and Reconstruction of Polyhedral Building Roofs From Aerial Lidar Point Clouds"

This paper presents a solution framework for the segmentation and reconstruction of polyhedral building roofs from aerial LIght Detection And Ranging (lidar) point clouds. The eigenanalysis is first carried out for each roof point of a building within its Voronoi neighborhood. Such analysis not only yields the surface normal for each lidar point but also separates the lidar points into planar and nonplanar ones. In the second step, the surface normals of all planar points are clustered with the fuzzy k-means method. To optimize this clustering process, a potential-based approach is used to estimate the number of clusters, while considering both geometry and topology for the cluster similarity. The final step of segmentation separates the parallel and coplanar segments based on their distances and connectivity, respectively. Building reconstruction starts with forming an adjacency matrix that represents the connectivity of the segmented planar segments. A roof interior vertex is determined by intersecting all planar segments that meet at one point, whereas constraints in the form of vertical walls or boundary are applied to determine the vertices on the building outline. Finally, an extended boundary regularization approach is developed based on multiple parallel and perpendicular line pairs to achieve topologically consistent and geometrically correct building models. This paper describes the detail principles and implementation steps for the aforementioned solution framework. Results of a number of buildings with diverse roof complexities are presented and evaluated. [J335]

"TerraSAR-X Instrument Calibration Results and Extension for TanDEM-X"

Spaceborne remote sensing with synthetic aperture radar (SAR) has become an essential source of high-resolution and continuous Earth observation. Modern satellites like the German TerraSAR-X system provide state-of-the-art radar images with respect to operating flexibility and imaging quality. The outstanding performance of TerraSAR-X image products is achieved by an innovative calibration approach that minimizes systematic antenna and instrument characteristics. The active phased array X-band antenna is fed by 384

transmit/receive modules for electronic beam steering and shaping in the azimuth and elevation direction. The flexible radar instrument hosts an internal calibration system which guarantees the high radiometric stability of all SAR products. New techniques for antenna performance control have been successfully implemented, setting a high standard for next-generation SAR missions. This paper summarizes all essential calibration results of TerraSAR-X that cover internal instrument behavior. Furthermore, we give an outlook on the required bistatic calibration techniques for the future TanDEM-X mission that faces additional performance challenges when calibrating two TerraSAR-X satellites flying in close formation. [J336]

"APC Trajectory Design for "One-Active" Linear-Array Three-Dimensional Imaging SAR"

This paper discusses the antenna phase center trajectory (APCT) design for the "one-active" linear-array 3D imaging SAR (LASAR). First, we discuss the principle of the one-active LASAR and demonstrate its feasibility by experiment. To describe the 3D spatial resolution of the one-active LASAR, the relationship between the 3D ambiguity function (AF) of the one-active LASAR and the system parameters is discussed in detail. Based on the analysis, we divide the APCT design into three topics: the direction of the linear array, the length of the linear array, and the switching mode of the active element [named as antenna phase center function (APCF)]. On the first topic, we conclude that, when the range, along-track, and cross-track directions are orthogonal to each other, the ambiguity region of the one-active LASAR attains minimum, and the 3D spatial resolution can be separated into the range, along-track, and cross-track resolutions. On the second topic, we find that the cross-track resolution is determined by the length of the linear array and the frequency of the carrier. To ensure that the length of the linear array is acceptable, the carrier should be W-band wave or millimeter wave. On the third topic, the effect of APCF is researched, and we find that both the periodic APCF and the pseudorandom APCF can produce 3D resolution, except for the periodic rectangle APCF. For the pseudorandom APCF and the periodic APCF with short period, the cross-range 2D AF is or can be approximated as the product of two 1D AFs in the along- and cross-track directions. Finally, the distribution of the pseudorandom APCF is optimized by the Lagrange multiplier method under the minimum variance criterion, and we find that, when the pseudorandom APCF obeys the parabolic distribution, the cross-range 2D AF is optimal. [J337]

"Minimum Entropy via Subspace for ISAR Autofocus"

In this letter, a novel approach to autofocus for inverse synthetic aperture radar (ISAR) imaging called minimum entropy via subspace autofocus is presented. This scheme uses the weighted signal subspace to express the phase errors left in the echoes after range-bin alignment and estimates the optimal weights sequentially via an optimization algorithm based on an entropy minimization principle, and its robustness and convergence can be ensured by the optimization method. Both the theoretical analysis and processing results of the real ISAR data have confirmed the feasibility of this new scheme. [J338]

"Assessment of TerraSAR-X Products with a New Feature Extraction Application: Monitoring of Cylindrical Tanks"

There is no doubt that retrieving observed scene features is one of the most interesting and challenging activities in all fields of remote sensing: The successful extraction of scene parameters may not only mean the success of the adopted procedure but also the success of a prediction model, an image product, a sensor project, or even an entire mission. This paper is partly concerned with this. The mission, the sensor, and the products at issue are the TerraSAR-X; the feature retrieval approach is the deterministic model-based approach already tested on E-SAR images and now in phase of improvement and testing on high-resolution TerraSAR-X images. Together with assessing the performances of TerraSAR-X products, this paper deals with a new application which, until now, has not received enough attention even if being worth of it: monitoring of big tanks in suburban or urban areas. Detailed discussion concerning the most suitable product for this kind of application is accompanied by retrieval results carried out on recently acquired TerraSAR-X images. [J339]

"Multichannel InSAR Building Edge Detection"

In this paper, the problem of building edge detection in synthetic aperture radar images is addressed. A new stochastic approach based on local Gaussian Markov random field (LGMRF) is proposed. The algorithm finds the edges of buildings starting from the estimation of the hyperparameters of the LGMRF model. The hyperparameters are seen as an indicator of the spatial correlation between adjacent pixels. The procedure is applied on interferometric data, using single-channel and multichannel configurations. The algorithm has been tested on simulated and real data, providing good results in both cases. [J340]

"First Analysis of TerraSAR-X Along-Track InSAR-Derived Current Fields"

We present the first analysis of surface current fields derived from TerraSAR-X along-track interferometric

synthetic aperture radar (along-track InSAR, ATI) data. The images were acquired over the mouth of the Elbe river (Germany) during six satellite overpasses in spring and summer 2008, using the experimental "aperture switching" mode of TerraSAR-X. In this mode, the phased-array synthetic aperture radar (SAR) antenna is split into two halves for receiving, but in contrast to the "dual receive antenna" mode, which uses two independent receivers in parallel, a single receiver is multiplexed to process signals from the two antenna halves in an alternating manner at a doubled pulse repetition frequency. The effective ATI baseline is on the order of 0.8 m. The SAR/ATI raw data processing is described in another paper in this issue. This paper focuses on the conversion of the basic interferograms into line-of-sight surface current fields, which includes an elimination of ship signatures, identification, and correction (as far as possible) of imaging artifacts, additional filtering and smoothing, and a subtraction of contributions of wave motions to detected velocities according to a theoretical model. We evaluate the quality of the results by comparison with current fields from a numerical flow model and with available in situdata. The ATI performance of TerraSAR-X is found to be basically consistent with theoretical expectations. After applying the same data processing algorithms to all six images, mean differences between TerraSAR-X-derived currents and reference currents in our main test area range from -0.11 to + 0.08 m/s in five of the six cases with one outlier at +0.42 m/s. The spatial current variations within the TerraSAR-X-derived current fields are consistent with the model in three cases, but unrealistically strong variations across the images are found in the other three cases. We attribute this to shortcomings of our preliminary raw data processi--ng algorithms, which can probably be fixed after some more detailed analysis and testing. The results obtained so far encourage us to believe that our internal performance goal of a typical current measuring accuracy of 0.1 m/s at an effective spatial resolution better than 1 km can be met. [J341]

"Soil Surface Water Content Estimation by Full-Waveform GPR Signal Inversion in the Presence of Thin Layers"

We analyzed the effect of shallow thin layers on the estimation of soil surface water content using full-waveform inversion of off-ground ground penetrating radar (GPR) data. Strong dielectric contrasts are expected to occur under fast wetting or drying weather conditions, thereby leading to constructive and destructive interferences with respect to surface reflection. First, synthetic GPR data were generated and subsequently inverted considering different thin-layer model configurations. The resulting inversion errors when neglecting the thin layer were quantified, and then, the possibility to reconstruct these layers was investigated. Second, laboratory experiments reproducing some of the numerical experiment configurations were conducted to assess the stability of the inverse solution with respect to actual measurement and modeling errors. Results showed that neglecting shallow thin layers may lead to significant errors on the estimation of soil surface water content(????>0.03 m3/m3), depending on the contrast. Accounting for these layers in the inversion process strongly improved the results, although some optimization issues were encountered. In the laboratory, the proposed full-waveform method permitted to reconstruct thin layers with a high resolution up to 2 cm and to retrieve the soil surface water content with an rmse less than 0.02 m3/m3, owing to the full-waveform inverse modeling. These results suggest that the proposed GPR approach is promising for field-scale mapping of soil surface water content of nondispersive soils with low electrical conductivity and for instances when soil layering is encountered. [J342]

"A Contribution of Polarimetry to Satellite Differential SAR Interferometry: Increasing the Number of Pixel Candidates"

This letter presents a general method for increasing the number of pixel candidates, those selected for processing in advanced differential SAR interferometry, by means of the exploitation of the polarimetric information provided by new satellite sensors. The algorithm is formulated for two different criteria of selection: the average coherence over the stack of interferograms and the amplitude dispersion index of the stack of images. Experimental results obtained with dual-pol images of TerraSAR-X over an urban area have demonstrated the expected improvement. The number of pixel candidates for an arbitrary threshold is 60% higher than that for single-pol data when using the average coherence and three times higher when using the dispersion index. The approach has also been compared to a selection based on a set of conventional channels (the copolar linear channels and the first two Pauli ones), showing a slight improvement for coherence selection and an important one for amplitude dispersion selection. [J343]

"Bistatic TerraSAR-X/F-SAR Spaceborne-Airborne SAR Experiment: Description, Data Processing, and Results"

We report about the first X-band spaceborne-airborne bistatic synthetic aperture radar (SAR) experiment, conducted early November 2007, using the German satellite TerraSAR-X as transmitter and the German Aerospace Center's (DLR) new airborne radar system F-SAR as receiver. The importance of the experiment resides in both its pioneering character and its potential to serve as a test bed for the validation of nonstationary bistatic acquisitions, novel calibration and synchronization algorithms, and advanced imaging techniques. Due to

the independent operation of the transmitter and receiver, an accurate synchronization procedure was needed during processing to make high-resolution imaging feasible. Precise phase-preserving bistatic focusing can only be achieved if time and phase synchronization exist. The synchronization approach, based on the evaluation of the range histories of several reference targets, was verified through a separate analysis of the range and Doppler contributions. After successful synchronization, nonstationary focusing was performed using a bistatic backprojection algorithm. During the campaign, stand-alone TerraSAR-X monostatic as well as interoperated TerraSAR-X/F-SAR bistatic data sets were recorded. As expected, the bistatic image shows a space-variant behavior in spatial resolution and in signal-to-noise ratio. Due to the selected configuration, the bistatic image outperforms its monostatic counterpart in almost the complete imaged scene. A detailed comparison between monostatic and bistatic images is given, illustrating the complementarity of both measurements in terms of backscatter and Doppler information. The results are of fundamental importance for the development of future nonsynchronized bistatic SAR systems. [J344]

"Estimation of Forest Structure, Ground, and Canopy Layer Characteristics From Multibaseline Polarimetric Interferometric SAR Data"

This paper concerns forest parameter retrieval from polarimetric interferometric synthetic aperture radar (PolInSAR) data considering two layers, one for the ground under the vegetation and one for the volumetric canopy. A model is designed to combine a physical model-based polarimetric decomposition with the random-volume-over-ground (RVoG) PolInSAR parameter inversion approach. The combination of a polarimetric scattering media model with a PolInSAR RVoG vertical structure model provides the possibility to separate the ground and the volume coherency matrices based on polarimetric signatures and interferometric coherence diversity. The proposed polarimetric decomposition characterizes volumetric media by the degree of polarization orientation randomness and by the particle scattering anisotropy. Using the full model enhances the estimation of the vertical forest structure parameters by enabling us to estimate the ground-to-volume ratio, the temporal decorrelation, and the differential extinction. For forest vegetation observed at L-band, this model accounts for the ground topography, forest and canopy layer heights, wave attenuation in the canopy, tree morphology in the form of the angular distribution and the effective shapes of the branches, and the contributions from the ground level consisting of surface scattering and double-bounce ground-trunk interactions, as well as volumetric understory scattering. The parameter estimation performance is evaluated on real airborne L-band SAR data of the Traunstein test site, acquired by the German Aerospace Center (DLR)'s E-SAR sensor in 2003, in both single- and multibaseline configurations. The retrieved forest height is compared with the ground-truth measurements, revealing, for the given test site, an average root-mean-square error (rmse) of about 5 m in the repeat-pass configuration. This implies an improvement in rmse by over 2 m in comparison to the pure coherence-based RVoG PolInSAR parameter inversion. [J345]

"Three-Dimensional Coherent Radar Backscatter Model and Simulations of Scattering Phase Center of Forest Canopies"

A 3-D coherent radar backscatter model for forest canopies was developed and used to improve the understanding of synthetic aperture radar (SAR) interferometric data. The model was based on a realistic 3-D spatial structure of a forest stand, in which every scatterer has its deterministic location. A backscattering signal from a scatterer was mapped into a pixel according to its range or signal time delay. The range or the time delay also determines the phase of the scattered field. All scattering matrices within a pixel were coherently added to yield the total backscattering field of the pixel. The coherent radar backscatter model takes into account not only the scattering contribution from the scatterers in the forest canopy but also the direct backscattering of the ground surface. Forest stands with three different spatial structures were simulated using L-system and field measurements. The number and sizes of trees in these forest stands were identical, but the 2-D arrangements of the trees were different. The interferometric SAR (InSAR) signals of these scenes were simulated using the 3-D coherent SAR model, and the heights of scattering phase centers were estimated from the simulated InSAR data. The results reported in this paper show that the spatial structures of vegetation play an important role in the location of the scattering phase center. The height of scattering phase center depends on canopy height, attenuation of canopy, and the gaps within the canopy. This paper shows that the spatial structure needs to be considered when the InSAR data are used for the estimation of forest structural parameters. [J346]

"SAR Image Despeckling Using Edge Detection and Feature Clustering in Bandelet Domain"

To effectively preserve the edges of a synthetic aperture radar (SAR) image when despeckling, an algorithm with edge detection and fuzzy clustering in the translation-invariant second-generation bandelet transform (TIBT) domain is proposed in this letter. A Canny operator is first utilized to detect and remove edges from the SAR image. Then, TIBT and fuzzy C-mean clustering are employed to decompose and despeckle the edge-removed image, respectively. Finally, the removed edges are added to the reconstructed image. The algorithm suggests

each coefficient in high-frequency subbands as the clustering feature, proposes a calculation method of the best clustering number, and defines the signal and noise in the clustering results. Experimental results show that the visual quality and evaluation indexes outperform the other methods with no edge preservation. The proposed algorithm effectively realizes both despeckling and edge preservation and reaches the state-of-the-art performance. [J347]

"Clutter Rank of STAP in MIMO Radar With Waveform Diversity"

In recent years, multiple-input multiple-output (MIMO) radar systems with space-time adaptive processing (STAP) have been proposed to improve radar performance. For MIMO radars with STAP, one big concern is the clutter rank. Current studies employ the rule of time-bandwidth product to predict the clutter rank of MIMO radars using orthogonal waveforms. This paper investigates clutter rank estimation for MIMO radar systems with more flexible waveform diversity, where waveforms are not constrained to be orthogonal. Under general waveform assumption, we have derived the clutter covariance matrix as a function of waveform covariance matrix (WCM). The clutter rank is then found to be determined by the rank and structure of the WCM. For different waveform cases, the WCM may be either full rank or rank deficient. Rules for estimation of clutter rank in these cases are provided and demonstrated by numerical simulations. [J348]

"A Novel Autofocusing Approach for Real-Time Through-Wall Imaging Under Unknown Wall Characteristics"

A novel real-time through-wall imaging (TWI) algorithm with autofocusing ability in the presence of wall ambiguities is proposed in this paper. The spectrum Green's function is employed to formulate the TWI algorithm, where the fast Fourier transform can be used to reconstruct the image in a very short computation time. The complex scattering process due to the presence of the wall is automatically included in the imaging formulation through the multilayer Green's function. The autofocusing is achieved by introducing a time factor in the TWI formulation to get a dynamic image at different focusing time. The image at the time instant when the defined entropy is minimized is stored as the output of the TWI result. Simulation results show that the proposed method can provide high-quality focused image in a short computation time regardless of the estimated value of the wall parameters. [J349]

"Ray-Tracing Simulation Techniques for Understanding High-Resolution SAR Images"

In this paper, a simulation concept is presented for creating synthetic aperture radar (SAR) reflectivity maps based on ray tracing. Three-dimensional models of man-made objects are illuminated by a virtual SAR sensor whose signal is approximated by rays sent through the model space. To this end, open-source software tools are adapted and extended to derive output data in SAR geometry followed by creating the reflectivity map. Rays can be followed for multiple reflections within the object scene. Signals having different multiple reflection levels are stored in separate image layers. For evaluating the potentials and limits of the simulation approach, simulated reflectivity maps and distribution maps are compared with real TerraSAR-X images for various complex man-made objects like a skyscraper in Tokyo, the Wynn Hotel in Las Vegas, and the Eiffel Tower in Paris. The results show that the simulation can provide very valuable information to interpret complex SAR images or to predict the reflectivity of planned SAR image acquisitions. [J350]

"Monitoring of Snow-Cover Properties During the Spring Melting Period in Forested Areas"

As spaceborne C-band synthetic aperture radar (SAR) observations are used for monitoring the snow cover during the spring melt period, temporal changes in backscatter from forest cover disturb the mapping of snow cover. This paper presents an analysis of snow backscattering properties in eight test areas situated around weather stations. Test areas represent open and forested landscapes in Northern Finland. Analyses are carried out using an extensive multitemporal ERS-2 C-band SAR data set from the snow melt period. We validate the following topics: 1) forest backscattering model for forest compensation; 2) Helsinki University of Technology (TKK) fractional snow-covered area (SCA) method with in situobservations; and 3) inversion of a combined forest/snow/ground backscattering model in an application to yield estimates of the relative changes of snow wetness during full snow cover conditions. The results show that the semiempirical TKK backscattering model describes the average C-band backscattering properties of all test regions well as a function of forest stem volume. Comparison of SCA estimation results with available ground-truth data also shows a good performance. The retrieved relative snow wetness values agree well with temperature observations. [J351]

"Compensation of Faraday Rotation in Multipolarization Scatterometry"

Spaceborne remote sensors operating at L-band and lower frequencies can significantly be affected by Faraday rotation (FR) as their signals pass through the Earth's ionosphere. A method of compensating for FR in

multipolarization scatterometry is introduced, which utilizes an ancillary estimate of the FR angle to retrieve corrected polarized scattered powers. Simulation results are presented to demonstrate the behavior of the FR correction process when radar speckle, instrument errors, and errors in the ancillary FR angle estimate are introduced. [J352]

"Segmentation and Classification of Polarimetric SAR Data Using Spectral Graph Partitioning"

A new approach for segmentation and classification of polarimetric synthetic aperture radar (POLSAR) data is proposed based on spectral graph partitioning. Since automated analysis techniques are often challenged due to the noisy properties of POLSAR data, human experts are employed to aid in the interpretation of such data in an operational setting. Humans can improve the performance of segmentation and classification of POLSAR data, because their vision system can apply cognitive skills that are not easy to incorporate into an automated system. The motivation for this paper is to incorporate some of these human perceptual skills into the computer algorithms. A framework that has recently emerged in computer vision for solving grouping problems with perceptually plausible results-spectral graph partitioning-is customized for POLSAR data. Segmentation is performed using the contour information in a region-based setting with the aid of spatial proximity. This is followed by a classification step performed through graph partitioning based on similarities of the mean coherence matrices obtained for each segment. Using the proposed approach, the results achieved are superior to the Wishart classifier. Automated parameter selection procedures are under development. This framework also suggests a way to accommodate different representations of polarimetric data and combine them with other information sources (e.g., optical imagery and digital elevation models). [J353]

"Derivation and Discussion of the SAR Migration Algorithm Within Inverse Scattering Problem: Theoretical Analysis"

The analysis of synthetic aperture radar (SAR) migration developed by Gilmore has been refined within the context of the inverse scattering problem, particularly the distorted-wave Born approximation (DWBA). The SAR migration algorithm can be deduced from the DWBA-based inversion formulation when the following assumptions are satisfied: 1) homogeneous and nonfrequency-dependent background medium; 2) the exploding source model; and 3) the well-resolved targets described by an orthogonal relation derived in this paper. In addition, the other contributions of this paper are as follows: 1) The removal of the ??2term has been clarified by the derived orthogonal relation; 2) a scale factor that balances the near-far field has been derived; and 3) a novel SAR migration algorithm for the imaging of targets embedded in a layered medium has been proposed. [J354]

"Evaluation of TerraSAR-X Observations for Wetland InSAR Application"

This paper assesses the potential of using spaceborne X-band synthetic aperture radar (SAR) data for monitoring water-level changes over wetlands. Our analysis is based on three sets of TerraSAR-X (TSX) observations acquired over South Florida's Everglades wetlands during an eight-month period in 2008. The first set was acquired in single HH polarization stripmap mode over our northern study area, consisting of managed wetlands and urban environments. The second set was acquired in dual-polarization stripmap mode over the western half of the same area, consisting mostly of managed wetlands. The third set was also acquired with dual-polarization stripmap mode over our southern study area, consisting of natural flow freshand salt-water wetlands in the southern Everglades. The first data set was used for a proof-of-concept study to verify that X-band data can generate coherent interferograms in wetland areas. Interferometric processing of this data set shows a high level of coherence (> 0.35) over both wetland and urban regions, maintaining interferometric phase in all three interferograms spanning 11 days. Surprisingly, phase is maintained over some of the wetlands even for interferograms spanning 33 days. The other two data sets were used to evaluate interferometric coherence of all four polarization modes and to determine dominant scattering mechanism in each wetland environment. Our results show high coherence values (> 0.4) in all polarization modes, with highest values in HH, then VV, and lowest in HV or VH. Interferograms calculated from multipolarization data show very similar fringe patterns regardless of the polarization type, suggesting that the phase information in all polarization data reflects water-level changes in wetlands and that volume scattering may be less important than commonly believed. We also used the two multipolarization data sets to conduct the Pauli decomposition, finding a strong dependence of scattering mechanism on vegetation t--ype. The high interferometric coherence level of all polarization data suggests that a significant part of the X-band scattered signal interacts with lower sections of the vegetation (trunks and branches), because scattering from wind-affected canopies cannot support such a high coherence level. The high spatial resolution of TSX, combined with its 11-day repeat orbit, makes this X-band sensor surprisingly suitable for wetland interferometric SAR applications. [J355]

"Gibbs Random Field Models for Model-Based Despeckling of SAR Images"

Synthetic aperture radar (SAR) images are affected by multiplicative noise called speckle. This noise makes automatic image classification and image interpretation difficult. Thus, many methods have been developed to remove speckle from SAR images while preserving the useful information of the scene such as texture and geometry. In this letter, a comparison between three different despeckling methods based on a Bayesian approach and Gibbs random fields is made. The used methods are Gauss-Markov random field (GMRF) and autobinomial modeling, which operate in the image domain, and the GMRF approach, which operates in the wavelet domain. Our methods are evaluated with synthetic and real SAR data (TerraSAR-X images). The experimental results show that, with these three methods, the speckle is well removed while structures are preserved; quantitative measures show that the autobinomial method provides the best smoothness and sharpness criteria in real SAR data, while the wavelet-based method generates the smallest bias. [J356]

"Analysis of Gable-Roofed Building Signature in Multiaspect InSAR Data"

The spatial resolution of state-of-the-art synthetic aperture radar sensors enables the structure analysis of urban areas. The appearance of buildings in magnitude images in settlements is dominated by the effects of the inherent oblique scene illumination. In urban residential districts, salient pairs of parallel lines of bright magnitude are often caused by direct reflection and double-bounce signal at gable-roofed buildings. In this letter, the magnitude and interferometric phase signature of gable-roofed buildings are discussed to extract reliable building features for reconstruction. The analysis contains signature changes by varying illumination and building geometry. The presented approach is aiming at the reconstruction of gable-roofed buildings by a knowledge-based analysis considering the discussed effects. The reconstruction results are assessed by using a high-resolution LIDAR surface model as ground truth. [J357]

"Quasi-Multistatic MIST Beamforming for the Early Detection of Breast Cancer"

Microwave imaging via space-time (MIST) beamforming has been shown to be one of the most promising imaging modalities for detecting small malignant breast tumors. This paper outlines two modifications to the MIST system developed by Hagness for the early detection of breast cancer, resulting in a quasi-multistatic MIST beamformer (multi-MIST). Multistatic MIST beamforming involves illuminating the breast with an ultrawideband (UWB) signal from one antenna while collecting the reflections at an array of antennas, as opposed to traditional monostatic MIST beamforming where only the transmitting antenna records the reflections from the breast. In order to process the multistatic data, traditional data-adaptive artifact removal algorithms have to be modified to accommodate signals from all antennas. Also, the MIST beamforming algorithm, which spatially focuses the signal and compensates for frequency-dependent propagation effects, has to be modified. The algorithms are tested on a 2-D anatomically accurate finite-difference time-domain model of the breast. The multi-MIST beamformer described here is shown to offer an improved signal to clutter ratio when compared to the traditional monostatic MIST beamformer. [J358]

"Despeckling of TerraSAR-X Data Using Second-Generation Wavelets"

This letter presents the despeckling of synthetic aperture radar (SAR) images within the bandelet and contourlet domains. A model-based approach is presented for the despeckling of SAR images. The speckle-reduced estimate is found using the first-order Bayesian inference, and the best model's parameters are estimated using the second-order Bayesian inference. Synthetic and real images are used for evaluating the qualities of the despeckling methods. The experimental results showed that the combination of Bayesian inference and bandelet transform outperforms the contourlet-based despeckling algorithm using synthetic data and objective measurements. [J359]

"Huber-Markov Model for Complex SAR Image Restoration"

This letter presents the despeckling of single-look complex (SLC) synthetic aperture radar (SAR) images using nonquadratic regularization. The objective function consists of an image model, a gradient, and a prior model. The Huber-Markov random field (HMRF) models the prior. A numerical solution is achieved through extensions of half-quadratic regularization methods using complex-valued SAR data. The proposed method using the HMRF prior together with nonquadratic regularization shows the superior results on SLC synthetic and actual SAR images. [J360]

"Road Network Extraction in VHR SAR Images of Urban and Suburban Areas by Means of Class-Aided Feature-Level Fusion"

In this paper, we propose to combine two road extractors from very high resolution synthetic aperture radar scenes: one more successful in rural areas and one explicitly designed for urban areas. In order to get the best combination of both, a rapid mapping filter for discriminating rural and urban scenes is utilized. Finally, the

results are fused on a feature level and connected by means of a network optimization. The approach is tested and evaluated on TerraSAR-X data containing complex urban areas and urban-rural fringe scenes. [J361]

"Hypothesis Testing in Speckled Data With Stochastic Distances"

Images obtained with coherent illumination, as is the case of sonar, ultrasound-B, laser, and synthetic aperture radar, are affected by speckle noise which reduces the ability to extract information from the data. Specialized techniques are required to deal with such imagery, which has been modeled by the G0distribution and, under which, regions with different degrees of roughness and mean brightness can be characterized by two parameters; a third parameter, which is the number of looks, is related to the overall signal-to-noise ratio. Assessing distances between samples is an important step in image analysis; they provide grounds of the separability and, therefore, of the performance of classification procedures. This paper derives and compares eight stochastic distances and assesses the performance of hypothesis tests that employ them and maximum likelihood estimation. We conclude that tests based on the triangular distance have the closest empirical size to the theoretical one, while those based on the arithmetic-geometric distances have the best power. Since the power of tests based on the triangular distance is close to optimum, we conclude that the safest choice is using this distance for hypothesis testing, even when compared with classical distances as Kullback-Leibler and Bhattacharyya. [J362]

"Communications-Inspired Sensing: A Case Study on Waveform Design"

Information theory, and particularly the mutual information (MI), has provided fundamental guidance for communications research. In Bell's 1993 paper, the MI was first applied to radar waveform design. Similar to its communications counterpart, the solution comes in a water-filling form. However, the practical meaning of MI in the sensing context remains unclear to date. Recently, Yang and Blum's 2007 paper shows that under the white noise assumption, the optimum water-filling scheme simultaneously maximizes the MI and minimizes the estimation minimum mean square error (MMSE). Such an equivalence, however, does not hold when the target parameter statistics are not perfectly known as shown in Yang and Blum's subsequent work. To further the understanding of the practical meaning of MI and to establish a connection between the MI and commonly adopted MSE measures for sensing, this paper takes a fresh look at the target estimation problem. We consider the general colored noise, incorporate the normalized MSE (NMSE), and develop joint robust designs for both the transmitter (waveforms) and the receiver (estimator) under various target and noise uncertainty models. Our results show that i) the optimum waveform designs resulted from the MI, MMSE and NMSE criteria are all different and ii) compared to MMSE, the NMSE-based designs share more similarities with the MI-based ones, especially when the target and noise statistics are not perfectly known. [J363]

"Applying the Freeman-Durden Decomposition Concept to Polarimetric SAR Interferometry"

In this paper, the Freeman-Durden polarimetric decomposition concept is adapted to polarimetric SAR interferometry (PolInSAR) data. The covariance matrix obtained from PolInSAR observations is decomposed into the three scattering mechanisms matrices proposed by Freeman and Durden for polarimetric SAR (PolSAR) data. The objective is to describe each interferometric cross correlation as the sum of the contributions corresponding to direct, double-bounce, and random volume scattering processes. This procedure enables the retrieval not only of the magnitude associated with each mechanism but also of their location along the vertical dimension of the scene. One of the most important features of this algorithm is the potential to isolate more accurately the direct and volume contributions which usually cannot be correctly separated by means of PolSAR measurements. In addition, it is also possible to distinguish between direct scattering responses originated either at ground or produced by upper layers of vegetation. The proposed algorithm has been tested with simulated data from PolSARProSim software, laboratory data from maize and rice samples, and airborne data from a test site with different scenarios. [J364]

"Cramer-Rao Bound for MIMO Radar Target Localization With Phase Errors"

Recent research indicates the potential of MIMO radar with dispersed antennas to achieve high target localization accuracy via coherent processing. Coherent processing requires phase synchronization. Usually, perfect phase synchronization is difficult to realize. Assuming frequency synchronization, possibly through reception of a beacon, and white noise, possibly due to estimating the covariance matrix and whitening the observations, we consider the impact of static phase errors at the transmitters and receivers for cases with sufficiently high SNR such that the Cramer-Rao bound (CRB) provides accurate performance estimates. We model the phase errors as random variables and discuss the impact of these errors on target localization performance. In a few example cases the CRB is computed and compared with those in the ideal coherent and noncoherent processing cases. For these examples, using numerical results, we will show that at high enough

signal-to-noise ratio (SNR), phase errors degrade performance only by a relatively small amount. [J365]

"Track-Before-Detect Strategies for STAP Radars"

In this correspondence we propose track-before-detect (TBD) strategies for space-time adaptive processing (STAP) radars. As a preliminary step we introduce the target and noise models in discrete-time form. Then, resorting to generalized likelihood ratio test (GLRT)-based and ad hoc procedures we derive detectors for two different scenarios (a point better clarified in the body of the correspondence). The preliminary performance assessment, conducted resorting to Monte Carlo simulation, shows that the proposed procedures might be viable means to implement early detection and track initiation of weak moving targets. [J366]

"ISAR Imaging of Maneuvering Targets Based on the Range Centroid Doppler Technique"

A new inverse synthetic aperture radar (ISAR) imaging approach is presented for application in situations where the maneuverability of noncooperative target is not too severe and the Doppler variation of subechoes from scatterers can be approximated as a first-order polynomial. The proposed algorithm is referred to as the range centroid Doppler (RCD) ISAR imaging technique and is based on the stretch Keystone-Wigner transform (SKWT). The SKWT introduces a stretch weight factor containing a range of chirp rate into the autocorrelation function of each cross-range profile and uses a 1-D interpolation of the phase history which we call stretch keystone formatting. The processing simultaneously eliminates the effects of linear frequency migration for all signal components regardless of their unknown chirp rate in time-frequency plane, but not for the noise or for the cross terms. By utilizing this novel technique, clear ISAR imaging can be achieved for maneuvering targets without an exhaustive search procedure for the motion parameters. Performance comparison is carried out to evaluate the improvement of the RCD technique versus other methods such as the conventional range Doppler (RD) technique, the range instantaneous Doppler (RID) technique, and adaptive joint time-frequency (AJTF) technique. Examples provided demonstrate the effectiveness of the RCD technique with both simulated and experimental ISAR data. [J367]

"Sequence Sets With Optimal Integrated Periodic Correlation Level"

Sequence sets with low periodic correlations are used in many areas, such as asynchronous code-division multiple access (CDMA) systems, medical imaging, radar and sonar. Lower bounds on the integrated sidelobe level (ISL) and the peak sidelobe level (PSL) of periodic sequence sets, under a power constraint, have been previously derived in the literature. In this letter, we obtain the ISL and PSL lower bounds using a different framework. The main contribution of the letter consists in using this framework to derive closed-form expressions for allpower constrained periodic sequence sets that meet the ISL lower bound. [J368]

"Code Design for Radar STAP via Optimization Theory"

In this paper, we deal with the problem of constrained code optimization for radar space-time adaptive processing (STAP) in the presence of colored Gaussian disturbance. At the design stage, we devise a code design algorithm complying with the following optimality criterion: maximization of the detection performance under a control on the regions of achievable values for the temporal and spatial Doppler estimation accuracy, and on the degree of similarity with a pre-fixed radar code. The resulting quadratic optimization problem is solved resorting to a convex relaxation that belongs to the semidefinite program (SDP) class. An optimal solution of the initial problem is then constructed through a suitable rank-one decomposition of an optimal solution of the relaxed one. At the analysis stage, we assess the performance of the new algorithm both on simulated data and on the standard challenging the Knowledge-Aided Sensor Signal Processing and Expert Reasoning (KASSPER) datacube. [J369]

"Equivalence Analysis of Accuracy of Geolocation Models for Spaceborne InSAR"

There are two main geolocation models for spaceborne synthetic aperture radar (SAR) interferometry (InSAR): range Doppler (RD) and direct geocoding (DG) models. The RD model gets the target position by combining and solving the Doppler equation, slant-range equation, and the modified Earth model equation. The DG location model gets the target position through its 3-D coordinates by the Doppler equation and two slant-range equations. Usually, the geolocation accuracy analyses of these two models are discussed separately. It is confused which one is more precise and we should use during InSAR system designing. This paper deduced and compared the geolocation accuracies of these two models in the same frame-matrix. According to the matrix theory, the explicit expressions of the geolocation uncertainty of RD and DG models were deduced through the use of parameters in matrix form. After defining a new slant-range plane coordinate system, the precision of RD geolocation model and that of geocoding location model were compared quantificationally. It was presented that the geolocation uncertainty formulas between RD and DG models were the same. Then, the conclusion that

these two models would lead to the same precision in geolocation measurement was obtained. At last, computer simulation results were employed to confirm the mathematical analysis. [J370]

"Validation and Calibration of ASCAT Using CMOD5.n"

The Advanced Scatterometer (ASCAT) onboard the Metop-A satellite became operational shortly after launch in 2006, and an absolute calibration using three transponders was achieved in November 2008. In this paper, we describe how the CMOD5.n ocean backscatter geophysical model function (GMF), which was derived using data from previous scatterometers onboard the European Remote Sensing 1 and 2 satellites (ERS-1 and ERS-2), was used to derive backscatter bias correction factors. The purpose is to remove the bias between ASCAT backscatter data and the CMOD5.n GMF output which allows these data to be used in place of ERS data in existing wind processing algorithms. The ASCAT Wind Data Processor, developed at the Royal Netherlands Meteorological Institute (KNMI), applies the bias correction factors to ASCAT data and uses CMOD5.n to retrieve wind vectors in order to produce an operational wind product. This resulted in a stable and high-quality ASCAT wind product since February 2007. We validate this product by comparing it to the European Centre for Medium-range Weather Forecasts (ECMWF) winds and buoy measurements. The bias correction factors indicate that ASCAT data and the GMF differ by roughly 0.3 dB below 55 ?and up to 0.8 dB above 55 ?. A possible explanation lies in CMOD5.n which has been poorly validated in this incidence angle regime. Validation of ASCAT data using the ocean calibration method confirms this result and also indicates that bias-corrected data are everywhere within 0.3 dB of CMOD5.n. The wind product validation shows an rms error of 1.3 m ?s-1in wind speed and 16 ?in wind direction when compared to ECMWF winds. This is better than the results achieved using ERS scatterometer data. Against buoy winds, we find an rms error wind component error of approximately 1.8 m ?s-1. These results show that the ASCAT wind product is of high quality and satisfies its wind component accuracy requirement of-- 2 m ?s-1. [J371]

"ISAR Imaging for Avian Species Identification With Frequency-Stepped Chirp Signals"

Imaging an avian target by inverse synthesis aperture radar (ISAR) is a novel and important technological approach of solving the problem of avian detection. However, the ISAR images of birds obtained with the conventional range-Doppler algorithm could be contaminated due to serious micro-Doppler effects, which are generated by the birds' flapping wings. In this letter, a novel imaging method of birds is proposed, which is simple to comprehend and operate, and avoids lots of complications and computation burdens. In the method, the moving status of bird is identified first via finding the variety of moving average values of the cross-correlation coefficient of the adjacent high-resolution range profiles. The usage of moving average values is attributed to the characters of the bird's flapping. The parts of respective flapping spectrogram can then be eliminated, and the parts of the residual spectrogram, i.e., the respective gliding spectrogram, can be connected to prepare for the cross-compression. In this letter, the minimum waveform entropy criterion and genetic algorithm are employed in the spectrogram connection to compensate the phase error. Finally, the feasibility and effectiveness of the methods are verified by simulation results. [J372]

"InSAR Coherence-Decomposition Analysis"

The phase coherence in synthetic aperture radar interferometry is often used in classification algorithms to detect possible temporal changes of the imaged terrain. However, in mountain areas, the interferometric coherence is also sensitive to the slight variations of the acquisition geometry. In this letter, we propose a very simple but effective method to separate the temporal decorrelation from the geometrical one. Assuming the imaged terrain can be modeled as a distributed target, the geometrical coherence can be estimated by exploiting a topographic model and the sensor acquisition parameters. The discrepancy between the geometrical coherence and the observed one can then be ascribed to temporal changes. Moreover, in presence of pointlike targets, the hypothesis of distributed terrain is no longer valid, and higher values of the observed coherence with respect to the synthetic geometrical one can be used to detect such targets. The proposed approach allows then in mountain areas the following conditions: (1) a simple and very fast rough estimation of the temporal coherence, and (2) the identification of pointlike targets using just two images. The method has been applied and tested in the Badong (China) site using European Remote Sensing satellite tandem data. [J373]

"Uncertainties in Ice-Sheet Altimetry From a Spaceborne 1064-nm Single-Channel Lidar Due to Undetected Thin Clouds"

In support of the Ice, Cloud, and land Elevation Satellite (ICESat)-II mission, this paper studies the bias in surface-elevation measurements caused by undetected thin clouds. The ICESat-II satellite may only have a 1064-nm single-channel lidar onboard. Less sensitive to clouds than the 532-nm channel, the 1064-nm channel tends to miss thin clouds. Previous studies have demonstrated that scattering by cloud particles increases the

photon-path length, thus resulting in biases in ice-sheet-elevation measurements from spaceborne lidars. This effect is referred to as atmospheric path delay. This paper complements previous studies in the following ways: First, atmospheric path delay is estimated over the ice sheets based on cloud statistics from the Geoscience Laser Altimeter System onboard ICESat and the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard Terra and Aqua. Second, the effect of cloud particle size and shape is studied with the state-of-the-art phase functions developed for MODIS cirrus-cloud microphysical model. Third, the contribution of various orders of scattering events to the path delay is studied, and an analytical model of the first-order scattering contribution is developed. This paper focuses on the path delay as a function of telescope field of view (FOV). The results show that reducing telescope FOV can significantly reduce the expected path delay. As an example, the average path delays for FOV= 167 ??rad (a 100-m-diameter circle on the surface) caused by thin undetected clouds by the 1064-nm channel over Greenland and East Antarctica are illustrated. [J374]

"Adaptive Design of OFDM Radar Signal With Improved Wideband Ambiguity Function"

We propose an adaptive technique to design the spectrum of an orthogonal frequency division multiplexing (OFDM) waveform to improve the radar's wideband ambiguity function (WAF). The adaptive OFDM signal yields a better auto-correlation function (ACF) that results into an improved delay (range) resolution for the radar system. First, we develop a mutlicarrier OFDM signal model and the corresponding WAF at the output of the matched filter, emphasizing that the received signal depends on the scattering parameters of the target. Then, we devise an optimization procedure to select the OFDM waveform such that the volume of the corresponding WAF best approximates the volume of a desired ambiguity function. We demonstrate the improvement in the resulting ambiguity function, along with the associated ACF, through numerical examples. We find that the optimization algorithm puts more signal energy at subcarriers in which the target response is weaker. [J375]

"Accurate Doppler Radar Noncontact Vital Sign Detection Using the RELAX Algorithm"

We consider using a Doppler radar for accurate noncontact vital sign detection. The Doppler radar first captures and downconverts the wireless signal that is phase modulated by the physiological movements, and then identifies the human heartbeat and respiration rates by processing the baseband signal. When nonlinear Doppler phase modulation is employed to monitor vital signs without contact, one of the challenges that we encounter is the presence of undesired harmonic terms and intermodulations other than the sinusoids of interest. A spectral estimation algorithm is needed to accurately estimate the sinusoidal frequencies before identifying the heartbeat and respiration rates. The conventional periodogram cannot reliably separate the rich sinusoidal components since it suffers from smearing and leakage problems, particularly for the case of limited data samples. A parametric and cyclic optimization approach, referred to as the RELAX algorithm, is instead suggested to mitigate these difficulties. Both simulated and experimental results are provided to validate the superiority of using the RELAX algorithm for accurate noncontact vital sign detection. [J376]

"Monitoring Subglacial Volcanic Eruption Using Ground-Based C-Band Radar Imagery"

The microphysical and dynamical features of volcanic clouds, due to Plinian and sub-Plinian eruptions, can be quantitatively monitored by using ground-based microwave weather radars. In order to demonstrate the unique potential of this remote sensing technique, a case study of a subglacial volcanic eruption, occurred in Iceland in November 2004, is described and analyzed. Volume data, acquired by a C-band ground-based weather radar, are processed to automatically classify and estimate ash particle concentration. The ash retrieval physical-statistical algorithm is based on a backscattering microphysical model of fine, coarse, and lapilli ash particles, used within a Bayesian classification and optimal regression algorithm. A sensitivity analysis is carried out to evaluate the overall error budget and the possible impact of nonprecipitating liquid and ice cloud droplets when mixed with ash particles. The evolution of the Icelandic eruption is discussed in terms of radar measurements and products, pointing out the unique features, the current limitations, and future improvements of radar remote sensing of volcanic plumes. [J377]

"Alternative Methodologies for the Internal Quality Control of Parallel LiDAR Strips"

Light Detection and Ranging (LiDAR) systems have been widely adopted for the acquisition of dense and accurate topographic data over extended areas. Although the utilization of this technology has increased in different applications, the development of standard methodologies for the quality control (QC) of LiDAR data has not followed the same trend. In other words, a lack in reliable, practical, cost-effective, and commonly acceptable QC procedures is evident. A frequently adopted procedure for QC is comparing the LiDAR data to ground control points. Aside from being expensive, this approach is not accurate enough for the verification of horizontal accuracy, unless specifically designed LiDAR targets are used. This paper is dedicated to providing accurate, economical, and convenient internal QC procedures for the evaluation of LiDAR data, which is

captured from parallel flight lines. The underlying concept of the proposed methodologies is that, in the absence of systematic and random errors in system parameters and measurements, conjugate surface elements in overlapping strips should perfectly match each other. Consistent incompatibilities and the quality of fit between conjugate surface elements in overlapping strips can be used to detect systematic errors in the system parameters/measurements and to evaluate the noise level in the LiDAR point cloud, respectively. Experimental results from real data demonstrate that all the proposed methods, with one exception, produce compatible estimates of systematic discrepancies between the involved data sets, as well as good quantification of inherent noise. [J378]

"TerraSAR-X Data for Burn Severity Evaluation in Mediterranean Forests on Sloped Terrain"

TerraSAR-X (TSX) dual-polarized synthetic aperture radar (SAR) data from a test site in Spain have been investigated to determine the relationship between forest burn severity and SAR backscatter. The role of the local incidence angle on the backscatter coefficient has been also studied. Burn severity was estimated by means of composition burn index plots and the remotely sensed differenced normalized burn ratio index. To infer the potential of the TSX data for burn severity assessment, the determination coefficients obtained from linear regression analysis have been used. At horizontal transmit horizontal receive (HH) polarization, backscatter increased for slopes oriented toward the sensor and areas affected by high burn severity, whereas, at horizontal transmit vertical receive (HV) polarization, higher backscatter occurred for slopes oriented away from the sensor in areas of low burn severity. The dependence of the backscatter coefficient on topography for areas affected by forest fire has been confirmed. The HH backscatter presented a clear descending trend with the increase in local incidence angle, whereas the HV backscatter presented an ascending trend. The determination coefficients showed that, at HH polarization, better estimates of burn severity are obtained at low local incidence angles, whereas, for HV polarization, the best estimates are obtained at high local incidence angles. The dual-polarized X-band SAR data showed potential for burn severity estimation in the Mediterranean environment if local incidence angle is accounted for. [J379]

"A Two-Dimensional Spectrum for General Bistatic SAR Processing"

This letter derives a 2-D point target spectrum for general bistatic synthetic aperture radar (SAR). For the bistatic configuration, the contributions of the transmitter and the receiver to the overall instantaneous Doppler are unequal due to the different slant range histories. In this letter, an instantaneous Doppler contribution ratio is proposed to represent the difference between the instantaneous Doppler contributions of the transmitter and the receiver, which varies with instantaneous Doppler and range frequency. Then, the 2-D spectrum is obtained by using the stationary phase principle and Taylor series expansion for general bistatic SAR. The accuracy of the spectrum is verified with a point target simulation of different general bistatic configurations. [J380]

"Bistatic Scattering of GPS Signals Off Arctic Sea Ice"

This paper evaluates the potential of a global positioning system (GPS) bistatic radar for the retrieval of information concerning the presence and condition of sea ice cover. For this purpose, the permittivityand roughnessof a ground scattering target at L-band are extracted from reflected GPS waveforms collected from an airborne platform using the Kirchhoff approximation for the surface cross section. The retrieved GPS estimates are then evaluated against collocated measurements of surface roughness obtained from a lidar profiler and a reference classification of sea ice types inferred from a multisensor data set that includes polarimetric microwave emissions, RADARSAT backscatter, and Moderate Resolution Imaging Spectroradiometer infrared/visible imagery. [J381]

"A Scatterometer System for Laboratory Study of Polarimetric Electromagnetic Signatures of Icy Hydrometeors"

Radar sensors with dual-polarization capability allow a better understanding and characterization of weather hazards, particularly hydrometeor particles. The knowledge of natural polarimetric hydrometeor scattering signatures, on the other hand, has been limited in theoretical calculations, simulations, and radar measurements. In this paper, an experimental approach was designed with the assistance of a controlled laboratory environment. An advanced vector network analyzer-based scatterometer system has been developed in harmony with an environmentally monitored anechoic chamber with special configurations for hydrometeor measurements. The polarimetric radar cross section (RCS) of various natural and man-made icy hydrometeor samples is measured across wide X-band frequencies and compared with theoretical modeling results. The dual-polarization radar variables and hydrometeor melting parameters are derived from the RCS measurements with interesting observations obtained. The described technology and results serve as the basis of a new hydrometer microphysics knowledge base for hydrometeor classification processing in the next-generation multichannel dual-

polarized hazard monitoring radars. [J382]

"A Physically Based Screen for Precipitation Over Complex Surfaces Using Passive Microwave Observations"

Physically based passive microwave precipitation retrievals are difficult to develop over land because high nonuniform land emissivity values are difficult to distinguish from those of clouds. This paper uses an empirical approach to determine the covariance of emissivity at different microwave window channels and relies on this covariance to estimate the portion of the observed brightness temperatures that may be attributable to rainfall. One year (2006) of global cloud-free surface emissivity values were retrieved using data sets from multiple instruments on NASA's Aqua satellite. Correlations between the emissivities at different channels were developed for use in an empirical model within an optimal estimation retrieval. The optimal estimation retrieves surface temperature, total column water vapor, cloud water, and the emissivity at the 10.7-GHz horizontally polarized channel. From this retrieval and the covariance of emissivities, the 89.0-GHz brightness temperature at both polarizations can be estimated. Significant differences between the observed and retrieved high-resolution brightness temperatures are used to screen for precipitation, and results are compared to ground-based radar data for several study regions representing a variety of land surface types in the U.S. The Heidke Skill Score is used to determine the robustness of this methodology and, in all cases, demonstrates at least some increase in skill relative to random chance. [J383]

"Coherent MapDrift Technique"

A new parametric autofocus technique with a high accuracy of flight-parameter estimation dedicated to strip-mode synthetic aperture radar (SAR) systems is presented. Most of the known autofocus techniques require high-reflectivity targets (man-made targets) to obtain a properly focused SAR image. The technique proposed in this paper allows flight parameters to be estimated effectively, even for a low-contrast scene (e.g., forests, fields, small paths, etc.). The autofocus technique is based on well-known MapDrift (MD) principles. The presented technique is a coherent one, which allows flight parameters to be estimated more precisely than in the other well-known parametric technique referred to as classical MD. The presented technique allows flight parameters to be estimated with accuracy that is independent of the initial velocity error. It can be used for real-time processing for both Earth imaging and moving-target indication. [J384]

"Typical Peak Sidelobe Level of Binary Sequences"

For a binary sequence Sn= {si: i=1,2,...,n} Γ‚Bï {Γ‚B±1}n, n> 1, the peak sidelobe level (PSL) is defined as M(Sn)=maxk=1,2,...,n-1|Γ‚Bïi=1n-kSiSi+k|. It is shown that the distribution of M(Sn) is strongly concentrated, and asymptotically almost surely Γ‚Bï(Sn)=(M(Sn))/Γ‚Bï(n ln n) Γ‚Bï [1-o(1),Γ‚Bï2]. Explicit bounds for the number of sequences outside this range are provided. This improves on the best earlier known result due to Moon and Moser that the typical Γ‚Bï(Sn) Γ‚Bï [o([1/(Γ‚Bï(ln n))]),2], and settles to the affirmative the conjecture of Dmitriev and Jedwab on the growth rate of the typical peak sidelobe. Finally, it is shown that modulo some natural conjecture, the typical Γ‚Bï(Sn) equals Γ‚Bï2. [J385]

"High-Resolution Imaging Using a Wideband MIMO Radar System With Two Distributed Arrays"

Imaging a fast maneuvering target has been an active research area in past decades. Usually, an array antenna with multiple elements is implemented to avoid the motion compensations involved in the inverse synthetic aperture radar (ISAR) imaging. Nevertheless, there is a price dilemma due to the high level of hardware complexity compared to complex algorithm implemented in the ISAR imaging system with only one antenna. In this paper, a wideband multiple-input multiple-output (MIMO) radar system with two distributed arrays is proposed to reduce the hardware complexity of the system. Furthermore, the system model, the equivalent array production method and the imaging procedure are presented. As compared with the classical real aperture radar (RAR) imaging system, there is a very important contribution in our method that the lower hardware complexity can be involved in the imaging system since many additive virtual array elements can be obtained. Numerical simulations are provided for testing our system and imaging method. [J386]

"Assessment of the Stereo-Radargrammetric Mapping Potential of TerraSAR-X Multibeam Spotlight Data"

TerraSAR-X can acquire image data in various resolutions down to a range of about 1 m. Moreover, the sensor can operate at various imaging beams and thus acquire image data at different off-nadir viewing angles. These circumstances led to a stimulation of the traditional stereo-mapping approach, as TerraSAR-X image pairs became available in high resolution and in various geometric dispositions. With respect to 3-D surface mapping,

TerraSAR-X stereo data processing, therefore, is a serious alternative to synthetic aperture radar interferometry, which can be addressed as the evolving mapping technique of the last decade. Within the TerraSAR-X science program of the German Aerospace Center (DLR), high-resolution multibeam data sets in Spotlight mode were acquired for several Austrian test sites. In general, three images were obtained from either ascending or descending orbits. In order to exploit the 3-D mapping accuracy of TerraSAR-X, stereo-radargrammetric mapping techniques were applied to the data sets, thereby utilizing stereo pairs as well as multi-image data sets in various dispositions. This paper focuses on one of the selected test sites and refers to the issues of 2-D and 3-D mapping-accuracy assessment as well as to surface model and vegetation-height-model generation. Validation of these products was widely restricted to visual analysis due to the lack of adequate high-quality reference products. [J387]

"Average Case Analysis of Multichannel Sparse Recovery Using Convex Relaxation"

This paper considers recovery of jointly sparse multichannel signals from incomplete measurements. Several approaches have been developed to recover the unknown sparse vectors from the given observations, including thresholding, simultaneous orthogonal matching pursuit (SOMP), and convex relaxation based on a mixed matrix norm. Typically, worst case analysis is carried out in order to analyze conditions under which the algorithms are able to recover any jointly sparse set of vectors. However, such an approach is not able to provide insights into why joint sparse recovery is superior to applying standard sparse reconstruction methods to each channel individually. Previous work considered an average case analysis of thresholding and SOMP by imposing a probability model on the measured signals. Here, the main focus is on analysis of convex relaxation techniques. In particular, the mixed l2,1approach to multichannel recovery is investigated. Under a very mild condition on the sparsity and on the dictionary characteristics, measured for example by the coherence, it is shown that the probability of recovery failure decays exponentially in the number of channels. This demonstrates that most of the time, multichannel sparse recovery is indeed superior to single channel methods. The probability bounds are valid and meaningful even for a small number of signals. Using the tools developed to analyze the convex relaxation technique, also previous bounds for thresholding and SOMP recovery are tightened. [J388]

"Supporting Drivers in Keeping Safe Speed and Safe Distance: The SASPENCE Subproject Within the European Framework Programme 6 Integrating Project PReVENT"

This paper describes a novel driver-support system that helps to maintain the correct speed and headway (distance) with respect to lane curvature and other vehicles ahead. The system has been developed as part of the Integrating Project PReVENT under the European Framework Programme 6, which is named SAfe SPEed and safe distaNCE (SASPENCE). The application uses a detailed description of the situation ahead of the vehicle. Many sensors [radar, video camera, Global Positioning System (GPS) and accelerometers, digital maps, and vehicle-to-vehicle wireless local area network (WLAN) connections] are used, and state-of-the-art data fusion provides a model of the environment. The system then computes a feasible maneuver and compares it with the driver's behavior to detect possible mistakes. The warning strategies are based on this comparison. The system "talks" to the driver mainly via a haptic pedal or seat belt and "listens" to the driver mainly via the vehicle acceleration. This kind of operation, i.e., the comparison between what the system thinks is possible and what the driver appears to be doing, and the consequent dialog can be regarded as simple implementations of the rider-horse metaphor (H-metaphor). The system has been tested in several situations (driving simulator, hardware in the loop, and real road tests). Objective and subjective data have been collected, revealing good acceptance and effectiveness, particularly in awakening distracted drivers. The system intervenes only when a problem is actually detected in the headway and/or speed (approaching curves or objects) and has been shown to cause prompt reactions and significant speed correction before getting into really dangerous situations. [J389]

"Benchmarking High-Resolution Global Satellite Rainfall Products to Radar and Rain-Gauge Rainfall Estimates"

This paper presents an in-depth investigation of the error properties of two high-resolution global-scale satellite rain retrievals verified against rainfall fields derived from a moderate-resolution rain-gauge network (25-30-km intergage distances) covering a region in the midwestern U.S. (Oklahoma Mesonet). Evaluated satellite retrievals include the NASA Tropical Rainfall Measuring Mission multisatellite precipitation analysis and the National Oceanic and Atmospheric Administration Climate Prediction Center morphing technique. The two satellite products are contrasted against a rain-gauge-adjusted radar rainfall product from the WSR-88D network in continental U.S. This paper presents an error characterization of the Mesonet rainfall fields based on an independent small-scale, but very dense (100-m intergage distances), rain-gauge network (named Micronet). The Mesonet error analysis, although significantly lower than the corresponding error statistics derived for the satellite and radar products, demonstrates the need to benchmark reference data sources prior to their quantitative use in validating remote sensing retrievals. In terms of the remote sensing rainfall products, this

paper provides quantitative comparisons between the two satellite estimates and the most definitive rain-gauge-adjusted radar rainfall estimates at corresponding spatial and temporal resolutions (25 km and 3 hourly). Error quantification presented herein includes zero- (rain detection probability and false alarm), first- (bias ratio), and second-order (root mean square error and correlation) statistics as well as an evaluation of the spatial structure of error at warm and cold seasons of 2004 and 2006. [J390]

"Delineation of Urban Footprints From TerraSAR-X Data by Analyzing Speckle Characteristics and Intensity Information"

With a spatial resolution of up to 1 m, the German radar satellite TerraSAR-X (TSX) has significantly increased the usability of spaceborne synthetic aperture radar (SAR) imagery in the context of urban applications. This paper presents an approach toward the semiautomated detection of built-up areas (BAs) based on single-polarized TSX images. The proposed methodology includes a specific preprocessing of the SAR data and an automated image analysis procedure. The preprocessing focuses on the analysis of local speckle characteristics in order to provide a texture layer that highlights BAs. In the context of an object-oriented image analysis, this texture layer is used along with the original intensity information to automatically extract settlements. The technique is tested on the basis of 12 TSX scenes covering representative urban agglomerations distributed throughout the world. Overall, accuracies between 76% and 96% for the derived city footprints demonstrate the high potential of both the TSX imagery and the proposed analysis approach in detecting BAs. In order to demonstrate the robustness and transferability of the image analysis concept, we finally transferred the classification strategy from the object-oriented domain to a more general and simplified pixel-based approach. [J391]

"Multistatic Synthetic Aperture Radar Image Formation"

In this paper, we consider a multistatic synthetic aperture radar (SAR) imaging scenario where a swarm of airborne antennas, some of which are transmitting, receiving or both, are traversing arbitrary flight trajectories and transmitting arbitrary waveforms without any form of multiplexing. The received signal at each receiving antenna may be interfered by the scattered signal due to multiple transmitters and additive thermal noise at the receiver. In this scenario, standard bistatic SAR image reconstruction algorithms result in artifacts in reconstructed images due to these interferences. In this paper, we use microlocal analysis in a statistical setting to develop a filtered-backprojection (FBP) type analytic image formation method that suppresses artifacts due to interference while preserving the location and orientation of edges of the scene in the reconstructed image. Our FBP-type algorithm exploits the second-order statistics of the target and noise to suppress the artifacts due to interference in a mean-square sense. We present numerical simulations to demonstrate the performance of our multistatic SAR image formation algorithm with the FBP-type bistatic SAR image reconstruction algorithm. While we mainly focus on radar applications, our image formation method is also applicable to other problems arising in fields such as acoustic, geophysical and medical imaging. [J392]

"Signal Processing for Improved Detection of Trapped Victims Using UWB Radar"

Detection of trapped victims using ultrawideband radar is considered a highly challenging task due to multiple unknown parameters and generally very low signal-to-noise-and-clutter ratio (SNCR) conditions. In this paper, we propose a novel detection algorithm which is designed for detection of periodic motion caused by, e.g., respiratory motion of the victim for low SNCR conditions. The aim is to separate the respiratory-motion response of a trapped victim from nonstationary clutter originating from moving objects in the scene of interest. The algorithm performs stationary-clutter removal, high-level noise, and nonstationary-clutter suppression, indicates presence of the trapped victim, and estimates its range. The performance of the algorithm is investigated, both by means of simulation and experimental verification. The results show improved detection capabilities in low SNCR over an existing algorithm proposed by Zaikov et al. [J393]

"Two-Dimensional Imaging via a Narrowband MIMO Radar System With Two Perpendicular Linear Arrays"

This paper presents a system model and method for the 2-D imaging application via a narrowband multiple-input multiple-output (MIMO) radar system with two perpendicular linear arrays. Furthermore, the imaging formulation for our method is developed through a Fourier integral processing, and the parameters of antenna array including the cross-range resolution, required size, and sampling interval are also examined. Different from the spatial sequential procedure sampling the scattered echoes during multiple snapshot illuminations in inverse synthetic aperture radar (ISAR) imaging, the proposed method utilizes a spatial parallel procedure to sample the scattered echoes during a single snapshot illumination. Consequently, the complex motion compensation in ISAR imaging can be avoided. Moreover, in our array configuration, multiple narrowband spectrum-shared waveforms

coded with orthogonal polyphase sequences are employed. The mainlobes of the compressed echoes from the different filter band could be located in the same range bin, and thus, the range alignment in classical ISAR imaging is not necessary. Numerical simulations based on synthetic data are provided for testing our proposed method. [J394]

"Evidence of Rainfall Signatures on X-Band Synthetic Aperture Radar Imagery Over Land"

Five spaceborne X-band synthetic aperture radars (X-SARs) are nowadays operating, and several more will be launched in the coming years. These X-SAR sensors, able to image the Earth's surface at metric resolution, may provide a unique opportunity to measure rainfall over land with spatial resolution of about a few hundred meters due to the moving-target degradation effects. This work is devoted to experimentally demonstrate this X-SAR capability, which can also be exploited to correct synthetic aperture radar (SAR) imagery for rainfall attenuation effects. Several case studies, selected from TerraSAR-X (TSX) overpasses over Europe and the southern U.S. in 2008, are qualitatively analyzed in terms of rainfall signatures. Visual validation of these rainfall SAR signatures is carried out by using available data from ground-based weather radars. A detailed data analysis for the case study of Hurricane ??Gustav?? on September 2, 2008, is carried out to assess a quantitative correlation among X-SAR response and near-surface precipitation rain rate. Two simplified empirical inversion algorithms, based on statistical regression and probability matching, are developed to retrieve rain rate from TSX cross-track ground-range measurements. The TSX-retrieved rain fields are compared to those estimated from the Next Generation Weather Radar (NEXRAD) in Mobile (Alabama, U.S.), showing a root-mean-square error less than 15 mm/h and a correlation of about 0.7. [J395]

"TerraSAR-X Antenna Calibration and Monitoring Based on a Precise Antenna Model"

The high flexibility and tight accuracy requirements of modern spaceborne synthetic aperture radar (SAR) systems require innovative technologies to calibrate and process SAR images. To perform accurate pattern correction during SAR processing, an antenna model can be used to derive the multitude of different antenna beams generated by active antenna steering. The application of such an antenna model could be successfully demonstrated for the TerraSAR-X mission, launched in 2007. The methodology and the results of the in-orbit verification with an achieved accuracy of better than ??0.2 dB are reviewed in this paper in detail, showing its outstanding accuracy. Additionally, the results of the antenna pattern long-term monitoring are described, pointing out the high stability of the system. [J396]

"Coherency Matrix Estimation of Heterogeneous Clutter in High-Resolution Polarimetric SAR Images"

This paper presents an application of the recent advances in the field of spherically invariant random vector (SIRV) modeling for coherency matrix estimation in heterogeneous clutter. The complete description of the polarimetric synthetic aperture radar (POLSAR) data set is achieved by estimating the span and the normalized coherency independently. The normalized coherency describes the polarimetric diversity, while the span indicates the total received power. The main advantages of the proposed fixed-point (FP) estimator are that it does not require any a prioriinformation about the probability density function of the texture (or span) and that it can directly be applied on adaptive neighborhoods. Interesting results are obtained when coupling this FP estimator with an adaptive spatial support based on the scalar span information. Based on the SIRV model, a new maximum-likelihood distance measure is introduced for unsupervised POLSAR classification. The proposed method is tested with both simulated POLSAR data and airborne POLSAR images provided by the Radar Ae?? roporte?? Multi-Spectral d'Etude des Signatures system. Results of entropy/alpha/anisotropy decomposition, followed by unsupervised classification, allow discussing the use of the normalized coherency and the span as two separate descriptors of POLSAR data sets. [J397]

"TerraSAR-X SAR Processing and Products"

The TerraSAR-X mission was launched in June 2007. After successful completion of the commissioning phase, the mission entered its operational phase in January 2008. Since that time, TerraSAR-X provides the scientific remote sensing community and commercial customers with high-quality spaceborne synthetic aperture radar (SAR) data products. The intention of this paper is to present the SAR data processing concept and the comprehensive portfolio of products reflecting the instrument's diverse imaging capabilities together with options of processing and achieved product quality as well as the essentials of SAR processing. Furthermore, it shall also provide details on how to fully exploit the precision of the TerraSAR-X products. [J398]

"Influence of Atmospheric Path Delay on the Absolute Geolocation Accuracy of TerraSAR-X High-Resolution Products"

Two coupled investigations of TerraSAR-X (TSX) high-resolution data are described in this paper: geometric validation, and estimation of the tropospheric path delay using measurements of corner reflectors (CRs) placed at different altitudes but nearly identical ranges. The CRs were placed within Alpine and valley sites in Switzerland, where terrain diversity provides ideal territory for geometric validation studies. Geometric validation was conducted using slant-range complex products from the spotlight and stripmap (SM) modes in ascending and descending configurations. Based on the delivered product annotations, the CR image positions were predicted, and these predictions were compared to their measuredimage positions. To isolate path delays caused by the atmosphere, six TSX SM scenes (~ 35 x 50 km) were examined containing four identical CRs with the same ranges and an altitude difference of ~ 3000 m. The CR arrangement made it possible to verify the annotated TSX atmospheric path delay by comparing the predicted slant range with the slant range obtained by measuring the reflector image coordinates. Range differences between the high- and low-altitude reflectors helped to quantify small variations in the path delay. Both SM and spotlight TSX products were verified to meet the specified accuracy requirements, even for scenes with extreme terrain variations, in spite of the simplicity of the atmospheric model currently integrated into the processor. Small potential improvements of the geolocation accuracy through the implementation of more comprehensive atmospheric modeling were demonstrated. [J399]

"Application of TerraSAR-X Data for Emergent Oil-Spill Monitoring"

Synthetic aperture radar (SAR) signals can propagate through hazardous weather and atmospheric conditions with heavy cloud cover, volcanic dust, snow, or rain. The all-weather capabilities of SARs have attracted significant interest in remote sensing communities, since serious environmental disasters such as oil spills have been highly ??elusive?? to optical sensors, making visible spectrum data vulnerable to rapidly changing atmospheric conditions. In this paper, we discuss the technical functionalities of TerraSAR-X from the emergency response perspective, describing its technical abilities in terms of a damping ratio, radiometric accuracy, and noise level with reference to the actual Hebei Spirit oil-spill incident that occurred on the west coast of the Korean peninsula in December 2007. The damping ratios estimated from the TerraSAR-X data as a function of Bragg wavenumber for various wind speeds indicate that TerraSAR-X data can be effectively used to identify oil-spill areas with acceptable accuracy. We also received ERS-2, ENVISAT, RADARSAT-1, and ALOS PALSAR data for this oil-spill event, not simultaneously but with varying time delays. The processing results for the multitemporal data sets obtained from the X- and C-band SAR systems are useful since they can be used to determine the near-real-time migration of spilt oil. The results of the current study indicate that there are distinct advantages of using X-band TerraSAR-X data for oil-spill detection compared to the data obtained at other available frequencies. [J400]

"Signatures of ERS-Envisat Interferometric SAR Coherence and Phase of Short Vegetation: An Analysis in the Case of Maize Fields"

Interferometric observations between the European Remote Sensing, ERS-2, synthetic aperture radar (SAR) and the Envisat Advanced SAR (ASAR) are unique since they are characterized by a short repeat-pass interval (28 min) and a perpendicular baseline of approximately 2 km. In vegetated areas, this configuration should preserve from strong temporal decorrelation and enhance the sensitivity of coherence and SAR interferometric (InSAR) phase to volumes with small heights. This assumption could be tested with the data acquired during the dedicated ERS-Envisat Tandem mission on October 15, 2007, over the Seeland region, Switzerland. Five maize fields and one sunflower field presented lower coherence and offsets of the interferometric phase, i.e. height, with respect to neighboring bare fields. To gain understanding on the interferometric signatures, the interferometric water cloud model was used to simulate coherence and InSAR height for the maize fields. Both the coherence and the InSAR height present clear dependence upon vegetation height and exhibit strong consistency. Simulations showed that the modeled coherence and InSAR height are most sensitive to the two-way attenuation and the temporal coherence of the vegetation. The best correspondence between the observed and modeled InSAR parameters was obtained with two-way attenuation values between 2 and 4 dB/m (corresponding to an extinction between 1 and 2 dB/m) and high temporal coherence of the vegetation (above 0.6), with this being due to the very stable conditions of the weather during the 28-min interval between image acquisitions. [J401]

"An Autonomous Interference Detection and Filtering Approach Applied to Wind Profilers"

An autonomous interference detection and filtering algorithm has been developed for removing the interference bands generated in the Doppler spectra of mesosphere-stratosphere-troposphere (MST) radar signals. The technique, implemented with the MST radar at Gadanki (13.5?? N, 79?? E), is based on identifying interferencelike band signals using a statistical signal variance approach for fixing the amplitude threshold, through which detecting the interference frequency and designing an adaptable notch filter to filter the undesired frequency bands are done. Signals received from the MST radar are sometimes contaminated with interference

signals received from other objects or generated within the system through arcing of high-power devices. Multiple interference bands with different characteristics are observed in the power spectra, which contaminate the wind information and other atmospheric signals. The autonomous interference detection and filtering algorithm is applied to various cases, and it is found that the interference signals could effectively be removed, leaving behind the original signals. By this approach, the effective number of signal samples obtained is increased, which helps one to improve the temporal resolution. [J402]

"Effect of Target Moisture on Laser Scanner Intensity"

We have studied the effect of moisture on the backscatter reflectance of mineral aggregate (such as sand and gravel) targets that are used as reflectance standards in airborne laser scanning intensity calibration. Target moisture has turned out to be a crucial factor when using external reference targets (either commercial or naturally available at the measurement site). The most common targets used thus far are different types of gravel and sand, which emphasizes the role of moisture because of the long time required for drying. We carried out laboratory and field experiments to find out how moisture affects the performance of these targets as reference standards. We found that even small amount of moisture has a crucial effect on target reflectance properties: The backscattered reflectance decreases strongly up to 10% gravimetric water content, after which the reflectance level mostly remains constant. The moisture effect has to be further studied and taken into account in the retrieval and calibration of laser scanner intensity data acquired in moist conditions. We also demonstrate a practical method of deriving the surface backscattered reflectance at different moisture contents with a digital camera. [J403]

"Optimal Joint Target Detection and Parameter Estimation by MIMO Radar"

We consider multiple-input multiple-output (MIMO) radar systems with widely spaced antennas. Such antenna configuration facilitates capturing the inherent diversity gain due to independent signal dispersion by the target scatterers. We consider a new MIMO radar framework for detecting a target that lies in an unknownlocation. This is in contrast with conventional MIMO radars which break the space into small cells and aim at detecting the presence of a target in a specified cell. We treat this problem through offering a novel composite hypothesis testing framework for target detection when 1) one or more parameters of the target are unknown and we are interested in estimating them, and 2) only a finitenumber of observations are available. The test offered optimizes a metric which accounts for both detection and estimation accuracies. In this paper, as the parameter of interest we focus on the vector of time-delays that the waveforms undergo from being emitted by the transmit antennas until being observed by the receive antennas. The analytical and empirical results establish that for the proposed joint target detection and time-delay estimation framework, MIMO radars exhibit significant gains over phased-array radars for extended targets which consist of multiple independent scatterers. For point targets modeled as single scatterers, however, the detection/estimation accuracies of MIMO and phased-array radars for this specific setup (joint target detection and time-delay estimation) are comparable. [J404]

"Performance of MIMO Radar With Angular Diversity Under Swerling Scattering Models"

The performance of statistical multiple-input multiple-output (MIMO) radar configurations that use distributed antennas is analyzed in this paper. Statistical MIMO radars exploit angular diversity to mitigate the impact of radar cross section (RCS) fluctuations. The fluctuations can be modeled with the Swerling scattering model consisting of four different cases with either fast or slow target RCS fluctuations. In this paper, the performance of different statistical MIMO radar configurations is compared in the different Swerling cases. Both target detection and direction of arrival estimation tasks are considered. We derive the optimal test statistics for target detection for non-orthogonal waveforms in all the Swerling cases in single-pulse as well as multi-pulse scenarios. We derive a closed-form density function for the test statistics under null and alternate hypotheses in the Swerling cases 1 and 2. For orthogonal waveforms in cases 3 and 4, the density function is given as a convolution involving a transcendental function. A suboptimal detector having a closed-form density function in cases 3 and 4 when the waveforms are orthogonal is introduced as well. In the direction finding task, confidence bounds of the squared estimation error of the different configurations are compared. The comparison is done in terms of the confidence bounds as the Cramer-Rao bounds are not defined for all the cases and configurations. The pros and cons of the angular diversity and each radar configuration are pointed out in different fluctuation scenarios. [J405]

"Noncausal Adaptive Spatial Clutter Mitigation in Monostatic MIMO Radar: Fundamental Limitations"

The problem of a point target detection masked by clutter distributed over range and Doppler, including the range and Doppler of the target, is considered for a multimode propagation scenario commonly encountered in

quasimonostatic HF over-the-horizon radars (OTHR). Here, a clutter signal spread in Doppler frequency due to propagation via a disturbed ionospheric layer competes with a target and narrowband clutter returns propagating via a stable ionospheric layer with the same group delay (radar range). Mitigation over all ranges of spread clutter propagating via a Г‚Вїmixed modeГ‚Вї path with indistinguishable direction-of-arrival (DoA) relative to the target requires (potentially adaptive) transmit beamforming to exploit the direction-of-departure (DoD) difference, which varies as a function of radar range. This range-dependent beamforming can be implemented only via the use of multiple-input multiple-output radar technology. In this paper, we explore the fundamental limitations that exist for the maximal dimension of the area in range-Doppler space occupied by spread clutter and the required properties (cardinality) of the orthogonal waveform set for efficient spread clutter mitigation. [J406]

"Multiple-Input Multiple-Output Radar for Lesion Classification in Ultrawideband Breast Imaging"

This paper studies the problem of applying multiple-input multiple-output (MIMO) radar techniques for lesion classification in ultrawideband (UWB) breast imaging. Ongoing work on this topic has suggested that benign and malignant masses, which usually possess remarkable architectural differences, could be distinguished by exploiting their morphology-dependent UWB microwave backscatter. We have previously approached this problem by deriving the complex natural resonances of the late-time target response, where the damping factors vary with the border profiles of anomalies. In this paper, we investigate the potential advantage of MIMO radar to enhance the resonance scattering phenomenon in breast tissue discrimination. MIMO radar can choose freely the probing signals transmitted via its antennas to exploit the independence between signals at the array elements, thereby enhancing the performance of target classification. Based on the observed damping factors and the receiver operating characteristics at different classifiers, which correspond to various diversity paths in the MIMO radar system, two data-fusion rules are proposed for robust lesion differentiation. Finally, numerical examples are provided to demonstrate the efficacy of the proposed imaging technique. [J407]

"Signaling Strategies for the Hybrid MIMO Phased-Array Radar"

The hybrid MIMO phased array radar (HMPAR) is a notional concept for a multisensor radar architecture that combines elements of traditional phased-array radar with the emerging technology of multiple-input multiple output (MIMO) radar. A HMPAR comprises a large number, MP, of T/R elements, organized into M subarrays of P elements each. Within each subarray, passive element-level phase shifting is used to steer transmit and receive beams in some desired fashion. Each of the M subarrays are in turn driven by independently amplified phase-coded signals which could be quasi-orthogonal, phase-coherent, or partially correlated. Such a radar system could be used in an airborne platform for concurrent search, detect, and track missions. This paper considers various signaling strategies which could be employed in the notional HMPAR architecture to achieve various objectives quantified by transmit beampatterns and space-time ambiguity functions. First, we propose a method to generate multiple correlated signals for uniform linear and rectangular arrays that achieve arbitrary rectangular transmit beampatterns in one and two dimensions, while maintaining desirable temporal properties. Examples of the range of transmit beampatterns possible with this technique are illustrated for an array of MP=900 elements, arranged using different values of M and P. Then the space-time, or MIMO, ambiguity function that is appropriate for the HMPAR radar system is derived. Examples of ambiguity functions for our signals using a one-dimensional HMPAR architecture are given, demonstrating that one can achieve phased-array-like resolution on receive, for arbitrary transmit beampatterns. [J408]

"MIMO Radar Waveform Constraints for GMTI"

Ground moving-target indication (GMTI) provides both an opportunity and challenge for coherent multiple-input multiple-output (MIMO) radar. MIMO techniques can improve a radar's angle estimation and the minimum detectable velocity (MDV) for a target. However, the challenge of clutter mitigation places significant constraints on MIMO radar waveforms. In this paper, the loss of target return because of clutter mitigation (signal-to-noise ratio (SNR) loss) is the driving performance metric. The ideal, orthogonal repeated-pulse waveform is shown not to exist. Pulse-to-pulse time-varying waveforms, such as Doppler-division multiple access (DDMA), are shown to offer SNR loss performance approaching ideal MIMO systems. [J409]

"Imaging of Moving Targets With Multi-Static SAR Using an Overcomplete Dictionary"

This paper presents a method for imaging of moving targets using multi-static radar by treating the problem as one of joint spatial reflectivity signal inversion with respect to an overcomplete dictionary of target velocities. Existing approaches to dealing with moving targets in SAR solve the nonlinear problem of target scattering and motion estimation typically through decoupled matched filtering. In contrast, by using an overcomplete dictionary approach we effectively linearize the forward model and solve the moving target problem as a larger, unified regularized inversion problem subject to sparsity constraints. This unified framework allows estimation of scatter

motion and reflectivity to be done in an optimal and global way. We show examples of the potential of the new method for sensing configurations with transmitters and receivers randomly dispersed in a multi-static geometry within a narrow forward cone around the scene of interest. [J410]

"Target Velocity Estimation and Antenna Placement for MIMO Radar With Widely Separated Antennas"

This paper studies the velocity estimation performance for multiple-input multiple-output (MIMO) radar with widely spaced antennas. We derive the Cramer-Rao bound (CRB) for velocity estimation and study the optimized system/configuration design based on CRB. General results are presented for an extended target with reflectivity varying with look angle. Then detailed analysis is provided for a simplified case, assuming an isotropic scatterer. For given transmitted signals, optimal antenna placement is analyzed in the sense of minimizing the CRB of the velocity estimation error. We show that when all antennas are located at approximately the same distance from the target, symmetrical placement is optimal and the relative position of transmitters and receivers can be arbitrary under the orthogonal received signal assumption. In this case, it is also shown that for MIMO radar with optimal placement, velocity estimation accuracy can be improved by increasing either the signal time duration or the product of the number of transmit and receive antennas. [J411]

"Sparse, Active Aperture Imaging"

We describe an approach to radar imaging of an isolated, rotating target using coherent, sparse, or highly thinned arrays of transmit/receive elements. The array elements are assumed to be randomly positioned and accurately surveyed after placement. Further, the isolated target is assumed to occupy a limited angular sector such that there is no source of backscatter beyond the sector occupied by the target. Estimates of the resolution and image quality are provided when the array elements are widely separated and operate with coherent, multiple-input multiple-output (MIMO) signaling and inverse synthetic aperture radar (ISAR) processing at each MIMO element pair. The sparse array operation can provide superior resolution when compared to the ISAR processing and accurate estimation of scattering properties with a modest number of sparse array elements. The performance of a model-based estimator to physical optics like scattering with MIMO signaling is described. Several important issues relating to feasibility remain to be investigated. These include establishing coherence and timing among the widely separated array elements, adaptive beamforming and processing requirements and coherence of the scattering phenomena with the widely separated MIMO elements. [J412]

"MIMO Radar Using Compressive Sampling"

A multiple-input multiple-output (MIMO) radar system is proposed for obtaining angle and Doppler information on potential targets. Transmitters and receivers are nodes of a small scale wireless network and are assumed to be randomly scattered on a disk. The transmit nodes transmit uncorrelated waveforms. Each receive node applies compressive sampling to the received signal to obtain a small number of samples, which the node subsequently forwards to a fusion center. Assuming that the targets are sparsely located in the angle-Doppler space, based on the samples forwarded by the receive nodes the fusion center formulates an l1-optimization problem, the solution of which yields target angle and Doppler information. The proposed approach achieves the superior resolution of MIMO radar with far fewer samples than required by other approaches. This implies power savings during the communication phase between the receive nodes and the fusion center. Performance in the presence of a jammer is analyzed for the case of slowly moving targets. Issues related to forming the basis matrix that spans the angle-Doppler space, and for selecting a grid for that space are discussed. Extensive simulation results are provided to demonstrate the performance of the proposed approach at difference jammer and noise levels. [J413]

"Approach based on combination of vector neural networks for emitter identification"

To deal with the problem of emitter identification caused by the measurement uncertainty of emitter feature parameters, this study proposes a new identification algorithm based on combination of vector neural networks (CVNN), which is deduced from the backpropagation vector neural network and can realise the non-linear mapping between the interval-value input data and the interval-value output emitter types. The key idea of CVNN is to adopt a combination of multiple multi-input/single-output neural networks to construct an identification system; each of the networks can only realise the identification function between two emitter types. Through quantitative analysis, it can be concluded that the proposed algorithm requires less computational load in the training stage. A number of simulations are presented to demonstrate the identification capability of the CVNN algorithm for emitter signals with and without additive noise. Simulation results show that the proposed algorithm not only has better identification capability, but also is relatively more insensitive to noise. [J414]

"Signals and Systems II Part I: Signals and their representations"

The goal of this series is a principles-based capability to design signal-processing architectures to convert signals between various forms. Signals are continuous-time or discrete-time, real or complex, and baseband or passband. Operations used on those signals include analog filtering, digital filtering, interpolation, decimation, and frequency shifts. The approach is rigorous but largely graphical with little explicit mathematics. [J415]

"Phase Spectrum of Signals in Ground-Penetrating Radar Applications"

The phase structure of ground-penetrating radar (GPR) signals operating on the basis of a stepped-frequency continuous wave (SFCW) is extracted to obtain additional information about the physical properties of buried objects. The phase structure is obtained from a signal-phase-frequency spectrum by applying the discrete Fourier transform to signals on the output of an SFCW georadar quadrature phase detector. We show that the phase gradient of a phase-frequency spectrum of signals reflected from underground layers and buried objects is determined by their electrical properties. We represent a signal phase structure during the georadar movement along the ground surface as an image of phase isolines (lines corresponding to the phase shift of n2??). We show that the spatial variability of isolines is determined by a medium physical property change or by the presence of inhomogeneous objects. [J416]

"Incremental learning approach based on vector neural network for emitter identification"

To deal with the problem of emitter identification (EID) caused by the measurement uncertainty of emitter feature parameters and to realise the automatic updating of the emitter database, which is usually used as emitter templates in identification processing, a vector neural network based incremental learning (VNNIL) approach for EID is proposed. This method combines the vector neural networks (VNNs) and the ensemble-based incremental learning (Learn++) algorithm. The VNN is adopted to construct a weak classifier and the Learn++ is used to generate ensembles of the weak classifiers. Considering that the VNN can realise the non-linear mapping between the interval-value input data and the interval-value output emitter types, and that the Learn++ can update the emitter database automatically, the VNNIL treats the two mentioned problems above as a single one and realises EID and parameters updating at the same time. A number of simulations are presented to demonstrate the identification and updating capability of the VNNIL algorithm. As shown in the simulation results, the VNNIL algorithm not only possesses a better learning and identification capability, but also achieves a better noise adaptability. [J417]

"On a Novel Approach Using MLCC and CFAR for the Improvement of Ship Detection by Synthetic Aperture Radar"

Multilook cross correlation (MLCC) is a useful technique in extracting the images of ships embedded in heavy sea clutter by synthetic aperture radar (SAR). In the ship detection experiment in 2006 by Phased Array L-band Synthetic Aperture Radar (PALSAR) on board the Advanced Land Observing Satellite, we applied MLCC to PALSAR data in order to extract small fishing boats. The result was that some boats were detected by thresholding MLCC coherence images under favorable conditions. However, it was also found that the threshold method was not suitable to automatically determine the threshold levels corresponding to the desired false alarm rate (FAR) values. In order to overcome this problem and to improve the accuracy of ship detection by MLCC, we propose a new and simple technique of MLCC-constant FAR (CFAR) or gamma-CFAR. In this method, CFAR is applied to interlook coherence images produced by MLCC. We tested this method using simulation and PALSAR data and then found out substantial improvement in signal-to-noise ratio and FAR in comparison with the coherence image alone. In this letter, we summarize the MLCC-CFAR algorithm and the experimental results. [J418]

"A wireless interrogation system exploiting narrowband acoustic resonator for remote physical quantity measurement"

Monitoring physical quantities using acoustic wave devices can be advantageously achieved using the wave characteristic dependence to various parametric perturbations (temperature, stress, and pressure). Surface acoustic wave (SAW) resonators are particularly well suited to such applications as their resonance frequency is directly influenced by these perturbations, modifying both the phase velocity and resonance conditions. Moreover, the intrinsic radio frequency (rf) nature of these devices makes them ideal for wireless applications, mainly exploiting antennas reciprocity and piezoelectric reversibility. In this paper, we present a wireless SAW sensor interrogation unit operating in the 434 MHz centered ISM band-selected as a tradeoff between antenna dimensions and electromagnetic wave penetration in dielectric media-based on the principles of a frequency sweep network analyzer. We particularly focus on the compliance with the ISM standard which reveals

complicated by the need for switching from emission to reception modes similarly to radar operation. In this matter, we propose a fully digital rf synthesis chain to develop various interrogation strategies to overcome the corresponding difficulties and comply with the above-mentioned standard. We finally assess the reader interrogation range, accuracy, and dynamics. [J419]

"Time Reversal in Multiple-Input Multiple-Output Radar"

Time reversal explores the rich scattering in a multipath environment to achieve high target detectability. Multiple-input multiple-output (MIMO) radar is an emerging active sensing technology that uses diverse waveforms transmitted from widely spaced antennas to achieve increased target sensitivity when compared to standard phased arrays. In this paper, we combine MIMO radar with time reversal to automatically match waveforms to a scattering channel and further improve the performance of radar detection. We establish a radar target model in multipath rich environments and develop likelihood ratio tests for the proposed time-reversal MIMO radar (TR-MIMO). Numerical simulations demonstrate improved target detectability compared with the commonly used statistical MIMO strategy. [J420]

"Segmentation of SAR Intensity Imagery With a Voronoi Tessellation, Bayesian Inference, and Reversible Jump MCMC Algorithm"

This paper presents a region-based approach to segmentation of the satellite synthetic aperture radar (SAR) intensity imagery. The approach is based on a Voronoi tessellation, the Bayesian inference, and the reversible jump Markov chain Monte Carlo (RJMCMC) algorithm. By Voronoi tessellation, the approach partitions a SAR image into a set of polygons corresponding to the components of the segmented homogenous regions. Each polygon is assigned a label to indicate a homogeneous region. The labels for all the polygons form a label field, which is characterized by an improved Potts model. The intensities of pixels in each polygon are assumed to satisfy identical and independent gamma distributions in terms of their label. Following the Bayesian paradigm, the posterior distribution that characterizes the SAR image segmentation can be obtained up to the integration constant. Then, a RJMCMC scheme is designed to simulate the posterior distribution and estimate its parameters. Finally, an optimal segmentation is obtained by the maximum a posteriori algorithm. The results obtained on both real Radarsat-1/2 and simulated SAR intensity images show that our approach works well and is very promising. [J421]

"Accurate UWB Radar Three-Dimensional Imaging Algorithm for a Complex Boundary Without Range Point Connections"

Ultrawide-band pulse radars have immeasurable potential for a high-range-resolution imaging in the near field and can be used for noncontact measurement of industrial products with specular or precision surfaces, such as reflector antenna or aircraft fuselage, or identifying and locating the human body in security systems. In our previous work, we developed a stable and high-speed 3-D imaging algorithm, Envelope, which is based on the principle that a target boundary can be expressed as inner or outer envelopes of spheres, which are determined using antenna location and observed ranges. Although Envelope produces a high-resolution image for a simple shape target that may include edges, it requires an exact connection for observed ranges to maintain the imaging quality. For complex shapes or multiple targets, this connection becomes a difficult task because each antenna receives multiple echoes from many scattering points on the target surface. This paper proposes a novel imaging algorithm without range point connection to accomplish high-quality and flexible 3-D imaging for various target shapes. The algorithm uses an accurate estimation for the direction of arrival using signal amplitudes and realizes direct mapping from observed ranges to target points. Several comparative studies of conventional algorithms clarify that our proposed method accomplishes accurate and reliable 3-D imaging even for complex or multiple boundaries. [J422]

"Reconstruction of GPR Signals by Spectral Analysis of the SVD Components of the Data Matrix"

This letter considers the problem of reconstructing total-time responses from noisy data collected by ground-penetrating radar (GPR). The well-known singularity expansion method (SEM)-a theory-for late-time response representation is generalized to establish a matrix model (data matrix)representing total-time responses of radar scattering waveforms. Using singular value decomposition of the data matrix-an intermediate processing technique, we present an approach to model-order determination and successfully reconstruct the total-time responses. The model order is quantitativelyselected by spectral analysis of left singular vectors of the data matrix and of the emitted waveform. The most important discoveries in this letter are as follows: (1) the GPR upper frequency can be used as a criterion for the selection of left singular vectors of the data matrix, and (2) the left singular vectors of the data matrix, which should not be neglected, tend to be predominantly low-pass functions and also provide valuable information for model-order determination. [J423]

"Multipolarization Microwave Scattering Model for Sahelian Grassland"

A coherent scattering formulation is developed for radar remote sensing of Sahelian grassland. This African vegetation is mainly composed of annual grass and shrubs. In the proposed procedure, first, a temporalmodel for generation of grass and shrub structures, which includes important realistic botanical information, is implemented. Because we develop a coherent scattering model, preserving the relative position of plant elements in a statistical manner as accurately as possible is very important. Shrubs are reproduced using cylindrical elements which represent trunks, branches, and thin green stems that function as leaves for these shrubs. Their crown shape is highly irregular, but for the most part can be encompassed in an ellipsoidal or cylindrical volume; on the other hand, the grass is represented as a set of cylindrical stalks and blade leaves. The scattered power from each grass element is added because multiple scattering among adjacent elements can be neglected at microwave frequencies. We calculate the soil scattering using the Integral Equation Method and neglect the soil volume scattering which may become significant for dry soil condition at high incidence angles. Backscatter statistics are acquired via a Monte Carlo simulation over a large number of realizations. The accuracy of the model is verified using measured data acquired by the C-band environmental satellite advanced synthetic aperture radar instrument at different incident angles. [J424]

"Investigation of Ocean Surface Wave Refraction Using TerraSAR-X Data"

As a scientific and technological continuation of the X-band Synthetic Aperture Radar (X-SAR) and Shuttle Radar Topography Mission (SRTM) missions, the new X-SAR, namely, TerraSAR-X (TSX), was launched on June 15, 2007. Since then, it has provided numerous high-quality data over land and ocean operationally. In this paper, surface wave refraction and diffraction are investigated using TSX imagery acquired over the coast of Terceira island situated in the North Atlantic. Peak wavelength and wave direction are determined by SAR 2-D image spectra. They are compared to measurements of X-band marine radar and results of the WAve prediction Model (WAM). Significant wave height in the near-shore shallow water region is estimated from TSX Spotlight mode data following the wave refraction laws and using the developed XWAVE empirical algorithm. Image spectra of the TSX subscenes in the full-coverage region are given to investigate significant changes of wave direction and length. By analyzing another TSX image acquired in StripMap mode, a shadow zone in the lee side of Terceira island is identified. It is influenced jointly by wave refraction and diffraction. Furthermore, a cross-sea pattern revealed in the image spectra is investigated. The cross sea is generated by the diffracted wave rays from the northern and southern coasts of the island. Less wave directional spreading for the cross-sea situation is observed as well when compared to the image spectra at the origin of diffraction. [J425]

"Covariance Estimation for dInSAR Surface Deformation Measurements in the Presence of Anisotropic Atmospheric Noise"

We study anisotropic spatial autocorrelation in differential synthetic aperture radar interferometric (dInSAR) measurements and its impact on geophysical parameter estimations. The dInSAR phase acquired by the satellite sensor is a superposition of different contributions, and when studying geophysical processes, we are usually only interested in the surface deformation part of the signal. Therefore, to obtain high-quality results, we would like to characterize and/or remove other phase components. A stochastic model has been found to be appropriate to describe atmospheric phase delay in dInSAR images. However, these phase delays are usually modeled as being isotropic, which is a simplification, because InSAR images often show directional atmospheric anomalies. Here, we analyze anisotropic structures and show validation results using both real and simulated data. We calculate experimental semivariograms of the dInSAR phase in several European Remote Sensing satellite-1/2 tandem interferograms. Based on the theory of random functions (RFs), we then fit anisotropic variogram models in the spatial domain, employing Mate??rn- and Bessel-family correlation functions in nested models to represent complex dInSAR covariance structures. The presented covariance function types, in the statistical framework of stationary RFs, are consistent with tropospheric delay models. We find that by using anisotropic data covariance information to weight dInSAR measurements, we can significantly improve both the precision and accuracy of geophysical parameter estimations. Furthermore, the improvement is dependent on how similar the deformation pattern is to the dominant structure of the anisotropic atmospheric signals. [J426]

"Building Height Retrieval From VHR SAR Imagery Based on an Iterative Simulation and Matching Technique"

Experimental airborne synthetic aperture radar (SAR) systems achieve spatial resolutions of approximately 10 cm, whereas the new spaceborne very high spatial resolution (VHR) SAR sensors onboard the TerraSAR-X and COSMO-SkyMed satellites achieve spatial resolutions down to 1 m. In VHR SAR data, features from individual urban structures (i.e., buildings) can be identified by their characteristic settings in urban settlement patterns. In this paper, we present a novel concept for the height estimation of generic man-made structures from single

detected SAR data. The proposed approach is based on the definition of a hypothesis on the height of the building and on the simulation of a SAR image for testing that hypothesis. A matching procedure is applied between the estimated and the actual SAR image in order to test the height hypothesis. The process is iterated for different height assumptions until the matching function is optimized, and thus, the building height is estimated. The efficiency of the proposed method is demonstrated on a set of 40 flat- and gable-roof buildings using two submeter VHR airborne and two 1-m resolution TerraSAR-X SAR scenes all acquired from the same residential area in Dorsten, Germany. The results show that, in the absence of string disturbing effects, the method is able to estimate the height of flat- and gable-roof buildings in the submeter data to the order of a meter, while the accuracy for the meter resolution spaceborne data is lower but still sufficient to estimate the number of floors of a building. [J427]

"Noise-Related Radiometric Correction in the TerraSAR-X Multimode SAR Processor"

Synthetic aperture radar (SAR) image intensity is disturbed by additive system noise. During SAR focusing, pattern corrections that are adapted to the characteristics of the wanted signal, but not to the characteristics of the noise, influence the spatial distribution of the noise power. Particularly in the case of ScanSAR, a distinct residual noise pattern in low backscatter areas results. This necessitates a noise-adapted radiometric correction of the focused image for almost all applications except interferometry. In this paper, we thoroughly investigate this topic. Based on signal theoretical and stochastic considerations, we develop a radiometric correction scheme. Simulations and the application of the algorithm to TerraSAR-X datatakes support the theoretical results. [J428]

"SAR Calibration Aided by Permanent Scatterers"

We propose a calibration method suitable for a set of repeated synthetic aperture radar (SAR) acquisitions that uses both absolute calibrated devices (such as corner reflectors) and stable targets identified in the scene [the permanent scatterers (PSs)]. Precisely, the role of the PS is to extend the initial calibration sequence by monitoring the radiometric stability of the system throughout the whole mission life span. At a first step, this paper approaches the problem of PS-based normalization by an iterative maximum-likelihood method that exploits the stack of complex interferometric SAR images. Two solutions are given based on different assumptions on the PS phases. As a second step, the merging of these estimates with the available calibration information is discussed. Results achieved by experimental acquisitions are shown in two different SAR systems: 1) a C-band spaceborne SAR and 2) a Ku-band ground-based SAR. [J429]

"The TerraSAR-X Mission and System Design"

This paper describes the TerraSAR-X mission concept within the context of a public-private partnership (PPP) agreement between the German Aerospace Center (DLR) and the industry. It briefly describes the PPP concept as well as the overall project organization. This paper then gives an overview of the satellite design and the corresponding ground segment, as well as the main mission parameters. After a short introduction to the scientific and commercial exploitation scheme, this paper finally focuses on the mission accomplishments achieved so far during the ongoing mission. [J430]

"Polarimetric Characterization and Temporal Stability Analysis of Urban Target Scattering"

This paper studies the polarimetric-dispersion properties of urban targets and their evolution along time in terms of the geometrical configuration. The relations between target geometry and the scattering behavior have been defined through the analysis of large stacks of simulated images. Scattering maps and synthetic aperture radar (SAR) images have been synthesized with the numerical tool GRaphical Electromagnetic COmputing SAR for different qualitative models of two real buildings. Ground-based SAR (GB-SAR) data acquired in a subsidence measurement campaign has been used to assess the simulator's realism. These data have permitted the identification of the critical simulation parameters and their range of recommended values for realistic simulations. In the context of very high resolution images, the results derived from this study may be crucial for making progress in urban-image postprocessing. As the different resolution cells comprise few scattering centers showing a quasi-deterministic scattering behavior, nonprobabilistic models based on target's geometry seem more suited for scattering modeling. In these models, the geometry-scattering (GS) links precisely inferred from simulated images can be very important. In addition to change detection and land classification, GS models may help in improving the interpretation of subsidence results with differential interferometry. Certainly, new processing algorithms can be developed exploiting the available scattering data with more physical sense. In addition, they can take more advantage of the fine resolution and polarimetric capabilities of the new sensors, like TerraSAR-X or RADARSAT-2. [J431]

"Fore and Aft Channel Reconstruction in the TerraSAR-X Dual Receive Antenna Mode"

The TerraSAR-X satellite is a high-resolution synthetic aperture radar (SAR) system launched in June 2007 which provides the option to split the antenna in along-track direction and sample two physical channels separately. Modern SARs are equipped with active phased array antennas and multiple channels. In order to keep costs low, TerraSAR-X uses the redundant receiver unit for the second channel such that fore and aft channel signals are combined by a hybrid coupler to form sum and difference channel data. The dual receive antenna (DRA) mode can either be used to acquire along-track interferometric data or to acquire signals with different polarizations at the same time (Quad-Pol). Fore and aft channel reconstruction is necessary if ground moving target indication (GMTI) algorithms such as the displaced phase center antenna technique or along-track interferometry shall be applied, and in order to separate the horizontally and vertically polarized received signal components. The proposed approach uses internal calibration pulses from different calibration beams in order to estimate and compensate the hardware impact. The theoretical framework together with the results from the experimental data evaluation for the fore and aft channel reconstruction of the TerraSAR-X DRA mode are presented. The impact of the receive hardware transformation matrix estimation accuracy on errors in the reconstructed fore and aft channel image data is studied, and first examples on the GMTI capability of the TerraSAR-X DRA mode are given. [J432]

"An Estimation Method for InSAR Interferometric Phase Based on MMSE Criterion"

In this paper, we propose a method based on minimum mean squared error (mmse) criterion to estimate synthetic aperture radar interferometry (InSAR) interferometric phase. In this method, the cross-correlation coefficient vector with large coregistration error is given first, and then, the cost function under the mmse criterion is used to estimate the InSAR interferometric phase. The method can auto-coregister the SAR images and reduce the interferometric phase noise simultaneously. Theoretical analysis and computer simulation results show that the method can provide an accurate estimate of the terrain interferometric phase (interferogram) even when the coregistration error reaches 1 pixel. [J433]

"Topographic Mapping of the German Tidal Flats Analyzing SAR Images With the Waterline Method"

The waterline method is used to derive the topography of the tidal flats along the German coast by evaluation of synthetic aperture radar (SAR) images. A series of about 70 European Remote Sensing Satellites SAR images of the German Bight taken at different water levels within four years is analyzed to detect the borderline between tidal flats and adjacent water areas using a wavelet-based edge-detection algorithm. After geocoding, the waterlines are combined with the corresponding water levels to represent the topography on an irregularly spaced grid. The water levels are taken from a numerical tide model and corrected with the measured gauge data. Interpolation of these data into a regular grid yields a topographic map of the intertidal zone. While the general practicability of this method has been demonstrated in previous studies for smaller test areas, this paper is the first attempt to generate maps of a large area on a yearly basis. [J434]

"Adaptive CLEAN With Target Refocusing for Through-Wall Image Improvement"

Signal processing techniques to improve building interior images are introduced. Specifically, an adaptive CLEAN algorithm is introduced in conjunction with target refocusing techniques to de-emphasize undesired signal effects from external walls, and thus more accurately image the lesser contrast objects. Instead of using the point spread function as in the conventional CLEAN algorithm, adaptive CLEAN incorporates a delay spread model found more appropriate for subtracting sidelobes that could obscure interior objects. Refocusing also allows for correcting target distortion and displacement due to through-wall propagation. It is shown that by combining adaptive CLEAN with target refocusing techniques, we are able to reconstruct interior targets (with minimal exterior wall distortion). The introduced processing techniques are demonstrated via simulations generated with a well validated high frequency ray tracing code, and with measured data. [J435]

"A Complex Generalized Gaussian Distribution- Characterization, Generation, and Estimation"

The generalized Gaussian distribution (GGD) provides a flexible and suitable tool for data modeling and simulation, however the characterization of the complex-valued GGD, in particular generation of samples from a complex GGD have not been well defined in the literature. In this correspondence, we provide a thorough presentation of the complex-valued GGD by: (i) constructing the probability density function (pdf); (ii) defining a procedure for generating random numbers from the complex-valued GGD; and (iii) implementing a maximum likelihood estimation (MLE) procedure for the shape and covariance parameters in the complex domain. We quantify the performance of the MLE with simulations and actual radar data. [J436]

"Statistical Analysis of a High-Resolution Sea-Clutter Database"

This paper presents the statistical analysis of an experimental high-resolution sea-clutter database, collected with a high-resolution Ka-band radar at the south coast of Spain. The main motivation of this paper has been to check the validity of the available theoretical models for high-resolution sea-clutter against data corresponding to a range resolution of centimeters. The overall amplitude probability density function (pdf), the compatibility with a compound representation, and the average spectral behavior of the data are analyzed in detail. Results clearly show the suitability of the compound Gaussian model and, more precisely, that the empirical pdf is well modeled by the generalized Kdistribution with log-normal texture. A close agreement has also been found between the estimated clutter spectral density and a power-law model. [J437]

"Estimating River Depth From Remote Sensing Swath Interferometry Measurements of River Height, Slope, and Width"

The Surface Water and Ocean Topography (SWOT) mission is a swath mapping radar interferometer that would provide new measurements of inland water surface elevation (WSE) for rivers, lakes, wetlands, and reservoirs. SWOT WSE estimates would provide a source of information for characterizing streamflow globally and would complement existing in situgage networks. In this paper, we evaluate the accuracy of river discharge estimates that would be obtained from SWOT measurements over the Ohio river and eleven of its major tributaries within the context of a virtual mission (VM). SWOT VM measurements are obtained by using an instrument measurement model coupled to simulated WSE from the hydrodynamic model LISFLOOD-FP, using USGS streamflow gages as boundary conditions and validation data. Most model pixels were estimated two or three times per 22-day orbit period. These measurements are then input into an algorithm to obtain estimates of river depth and discharge. The algorithm is based on Manning's equation, in which river width and slope are obtained from SWOT, and roughness is estimated a priori.SWOT discharge estimates are compared to the discharge simulated by LISFLOOD-FP. Instantaneous discharge estimates over the one-year evaluation period had median normalized root mean square error of 10.9%, and 86% of all instantaneous errors are less than 25%. [J438]

"TerraSAR-X Mission Planning System: Automated Command Generation for Spacecraft Operations"

On June 15, 2007, TerraSAR-X was successfully launched from Baikonur, Kazakhstan. On board TerraSAR-X, a high-resolution X-band synthetic aperture radar (SAR) instrument is being operated as the primary payload. The user community requesting SAR products is composed of commercial and scientific partners as documented in a public-private-partnership agreement. The operations of the TerraSAR-X bus as well as payload operations are performed by the Mission Operations Segment (MOS). The Mission Planning System (MPS), which is a part of the MOS, has been designed to handle complex payload and standard bus operations in an automated manner. The purpose of this paper is to describe the concepts and the TerraSAR-X realization of the MPS. [J439]

"Sonar Measurements in Ship Wakes Simultaneous With TerraSAR-X Overpasses"

A pilot experiment was conducted in the period from April to June 2008 in the Straits of Florida near Port Everglades, Florida, in order to study the dynamics of far wakes of ships. In this experiment, a small boat with downward-looking sonar made ??snakelike?? sections through wakes of ships of opportunity during the TerraSAR-Xoverpasses. The ship and its parameters (length, speed, course, etc.) were identified utilizing an automated identification system. The sonar responded to the clouds of microbubbles generated in the ship wake by the propulsion system and ship-hull turbulence. The ship wakes were traced in the sonar signal typically from 10 to 30 min after the ship's passage. A preliminary analysis of the measurements suggests that the visibility of the centerline ship wake in synthetic aperture radar (SAR) images is correlated with the presence of microbubbles in the wake. This supports the hypothesis that natural surfactants scavenged and brought to the surface by rising bubbles play an important role in the wake visibility in SAR. The influence of the wind-wave field on the ship wake, as well as the effect of screening of the wind-wave field by the ship's hull, adds another level of complexity to wake patterns observed in SAR images. [J440]

"Polarimetric MIMO Radar With Distributed Antennas for Target Detection"

Multiple-input-multiple-output (MIMO) radar systems with widely separated antennas enable viewing the target from different angles, thereby providing spatial diversity gain. Polarimetric design of the transmit waveforms based on the properties of the target scattering matrix provides better performance than transmitting waveforms with only fixed horizontal or vertical polarizations. We propose a radar system that combines the advantages of both systems by transmitting polarized waveforms from multiple distributed antennas, in order to detect a point-like stationary target. The proposed system employs 2-D vector sensors at the receivers, each of which

measures the horizontal and vertical components of the received electric field separately. We design the Neyman-Pearson detector for such systems. We derive approximate expressions for the probability of false alarm (PFA) and the probability of detection (PD). Using numerical simulations, we demonstrate that optimal design of the antenna polarizations provides improved performance over MIMO systems that transmit waveforms of fixed polarizations over all the antennas. We also demonstrate that having multiple widely separated antennas gives improved performance over single-input-single-output (SISO) polarimetric radar. We also demonstrate that processing the vector measurements at each receiver separately gives improved performance over systems that linearly combine both the received signals to give scalar measurements. [J441]

"On the Design of a Compact Neural Network-Based DOA Estimation System"

A system to measure the direction of arrival (DOA) of a signal within a 45-degree conical sector is demonstrated. The system is compact and uses only four circularly polarized patch elements. A printed beamforming network is used to create a set of partially overlapping beams allowing DOA estimation without ambiguity. Neural networks are used to first classify the antenna signals and then estimate the DOA. The proposed system was validated experimentally in C band and, in spite of the highly disturbed beams caused by the finite size of the antenna platform, it was shown that DOA estimation errors in the order of one degree were achievable under signal-to-noise ratios of 10 dB. [J442]

"Final TerraSAR-X Calibration Results Based on Novel Efficient Methods"

TerraSAR-X is a satellite mission for scientific and commercial applications operating a highly flexible X-band synthetic aperture radar (SAR) instrument with a multitude of different operation modes. As product quality is of crucial importance, the success or failure of the mission depends essentially on the method of calibrating TerraSAR-X in an efficient way during commissioning the entire system in a restricted time. Only then, product quality and the correct in-orbit operation of the entire SAR system can be ensured. This paper describes the in-orbit calibration method for TerraSAR-X and dedicated activities performed during the commissioning phase as well as final results derived from all calibration procedures. [J443]

"A Backscatter Modeling for River Ice: Analysis and Numerical Results"

A microwave backscatter model was developed to help provide an understanding of the interaction of a radar signal with the different ice types formed on natural freshwater bodies. This model was based on the radiative transfer theory, which is solved by the doubling matrix method. This numerical method provides an explanation for scattering effects due to volume, boundaries, boundary-volume interactions and interactions between layers. Three ice types were analyzed: columnar ice, frazil ice, and snow ice. Simulations with the model proved that the radar response from river ice cover depends on both ice-cover boundaries. The shape and distribution of air inclusions within the different ice types seem to have a significant impact on their contributions to the total response. The presence of tubular air inclusions within columnar ice causes an increase in the total response as a result of a double-bounce scattering. Small spherical and closed air inclusions within snow ice and frazil ice generate significant backscattering at high frequencies due to volume and surface-volume scattering. A further increase in the ice-cover thickness with air inclusions also causes increased scattering. Superposing two or more of these ice types causes considerable multiple scattering between layers. Finally, radar ice measurements collected over the Athabasca River were employed to further validate the model, and satisfactory results were obtained. [J444]

"Micro-Doppler Effect Analysis and Feature Extraction in ISAR Imaging With Stepped-Frequency Chirp Signals"

The micro-Doppler (m-D) effect induced by the rotating parts or vibrations of the target provides a new approach for target recognition. To obtain high range resolution for the extraction of the fine m-D signatures of an inverse synthetic aperture radar target, the stepped-frequency chirp signal (SFCS) is used to synthesize the ultrabroad bandwidth and reduce the requirement of sample rates. In this paper, the m-D effect in SFCS is analyzed. The analytical expressions of the m-D signatures, which are extracted by an improved Hough transform method associated with time-frequency analysis, are deduced on the range-slow-time plane. The implementation of the algorithm is presented, particularly in those extreme cases of rotating (vibrating) frequencies and radii. The simulations validate the theoretical formulation and robustness of the proposed m-D extraction method. [J445]

"On Aperiodic-Correlation Bounds"

We present a new derivation of a lower bound for an aperiodiccorrelation metric: the integrated sidelobe level (ISL) of a set of sequences under the energy constraint. Sequences (or sequence sets) with low aperiodic correlations are widely demanded in many applications, including radar/sonar range compression, medical

imaging, channel estimation and multi-user spread-spectrum communications. While the lower bound has been implicitly discussed in the literature before, here we adopt a different framework to derive the bound. In particular, we make use in the derivation of our recently proposed cyclic algorithm framework, which can also be used to efficiently synthesize unimodular sequences with low correlations. We also show that by relaxing the unimodular constraint, the ISL lower bound can be approached closely. [J446]

"Pole Assignment With Improved Control Performance by Means of Periodic Feedback"

This technical note is concerned with the pole placement of continuous-time linear time-invariant (LTI) systems by means of LQ suboptimal periodic feedback. It is well-known that there exist infinitely many generalized sampled-data hold functions (GSHF) for any controllable LTI system to place the modes of its discrete-time equivalent model at prescribed locations. Among all such GSHFs, this technical note aims to find the one which also minimizes a given LQ performance index. To this end, the GSHF being sought is written as the sum of a particular GSHF and a homogeneous one. The particular GSHF can be readily obtained using the conventional pole-placement techniques. The homogeneous GSHF, on the other hand, is expressed as a linear combination of a finite number of functions such as polynomials, sinusoidals, etc. The problem of finding the optimal coefficients of this linear combination is then formulated as a linear matrix inequality (LMI) optimization. The procedure is illustrated by a numerical example. [J447]

"Development of the TanDEM-X Calibration Concept: Analysis of Systematic Errors"

The TanDEM-X mission, result of the partnership between the German Aerospace Center (DLR) and Astrium GmbH, opens a new era in spaceborne radar remote sensing. The first bistatic satellite synthetic aperture radar mission is formed by flying TanDEM-X and TerraSAR-X in a closely controlled helix formation. The primary mission goal is the derivation of a high-precision global digital elevation model (DEM) according to High-Resolution Terrain Information (HRTI) level 3 accuracy. The finite precision of the baseline knowledge and uncompensated radar instrument drifts introduce errors that may compromise the height accuracy requirements. By means of a DEM calibration, which uses absolute height references, and the information provided by adjacent interferogram overlaps, these height errors can be minimized. This paper summarizes the exhaustive studies of the nature of the residual-error sources that have been carried out during the development of the DEM calibration concept. Models for these errors are set up and simulations of the resulting DEM height error for different scenarios provide the basis for the development of a successful DEM calibration strategy for the TanDEM-X mission. [J448]

"Contrast-Optimization-Based Range-Profile Autofocus for Polarimetric Stepped-Frequency Radar"

One of the main benefits brought by the use of fully polarimetric radars is the ability to identify scattering mechanisms, which are related to the target physical properties. One of the most critical problems in synthetic range-profile reconstruction is the distortion induced by the target motion. Radial target velocity and acceleration generate second- and third-order phase terms in the received signal, which produce range shift and point-spread-function smearing. The distortions induced by the target motion produce, as a consequence, a signal-to-noise ratio loss. Recently, a method based on contrast maximization has been proposed in order to compensate target radial motions using single-polarization data. In this paper, an extension of such an algorithm is proposed that exploits fully polarimetric data in order to improve the target radial motion compensation. [J449]

"Interferometric Microrelief Sensing With TerraSAR-X-First Results"

The meter-scale ground resolution of TerraSAR-X spotlight images promises for the first time the 3-D detection of landforms and landform changes on the microrelief scale from a satellite-based remote sensing system. Using repeat-pass pairs of high-resolution spotlight images, this paper analyzes the spatial variation of coherence on the micro- and mesorelief scale and demonstrates the high potential as well as some limitations of this approach for digital elevation model generation, geomorphological mapping, and geomorphic-change detection in contrasting landscapes of the coastal desert of southern Peru. [J450]

"Terrain Modeling From Lidar Range Data in Natural Landscapes: A Predictive and Bayesian Framework"

The Earth's topography, including vegetation and human-made features, reduced to a virtual 3-D representation is a key geographic layer for any extended development or risk management project. Processed from multiple aerial images or from airborne lidar systems, the 3-D topography is first represented as a point cloud. This paper deals with the generation of digital terrain models (DTMs) in natural landscapes. We present a global methodology for estimating the terrain height by deriving a predictive filter paradigm. Under the assumption that

the terrain topography (elevation and slope) is regular in a neighboring system, a predictive filter combines linearly the predicted topographic values and the effective measured values. In this paper, such a filter is applied to 3-D lidar data which are known to be of high elevation accuracy. The algorithm generates an adaptive local geometry wherein the elevation distribution of the point cloud is analyzed. Since local terrain elevations depend on the local slope, a predictive filter is first applied on the slopes and then on the terrain elevations. The algorithm propagates through the point cloud following specific rules in order to optimize the probability of computing areas containing terrain points. Considered as an initial surface, the previous DTM is finally regularized in a Bayesian framework. Our approach is based on the definition of an energy function that manages the evolution of a terrain surface. The energy is designed as a compromise between a data attraction term and a regularization term. The minimum of this energy corresponds to the final terrain surface. The methodology is discussed, and some conclusive results are presented on vegetated mountainous areas. [J451]

"Statistical Linear Destriping of Satellite-Based Pushbroom-Type Images"

This paper introduces a new self-calibration destriping technique for pushbroom-type satellite imaging systems. Self-calibration means that no specific training data are required. It is based on the statistical estimation of each detector gain from the observed image, assuming a linear response. Both theoretical and practical behaviors are studied. Our technique is shown to outperform simpler techniques based on column averages in terms of gain estimation precision while keeping the computational cost within admissible limits. [J452]

"Focus FMCW SAR Data Using the Wavenumber Domain Algorithm"

The combination of frequency-modulation continuous-wave (FMCW) technology and synthetic aperture radar (SAR) promises a lightweight, cost-effective, and high-quality imaging sensor for remote sensing. However, the long signal duration time leads to the failure of the conventional start/stop approximation of the pulsed SAR. In this paper, a signal model is proposed to address the effects of the continuous motion during the transmit time on the echoed signal. Based on the model, an analytical point target reference spectrum is derived. From the spectrum, it will be seen that the continuous motion introduces an additional range-azimuth coupling term and a range walk term compared with the conventional pulsed SAR. The range walk term is well known, whereas the foregoing range-azimuth coupling term is formulated for the first time in the FMCW SAR community. For the squint and spotlight modes, these range walk and range-azimuth coupling terms might significantly degrade the image quality. In this paper, based on the proposed analytical signal model, we further discuss the application of the wavenumber domain algorithm for the FMCW SAR data. In addition, different approximations of the Stolt mapping are made to highlight the effect of the range-dependent higher-order range-azimuth coupling terms on the 2-D impulse responses. Finally, X-band simulated experiments and Ka-band real FMCW SAR data are used to validate the signal model and the processing method. [J453]

"Mutual-Information-Based Registration of TerraSAR-X and Ikonos Imagery in Urban Areas"

The launch of high-resolution remote sensing satellites like TerraSAR-X, WorldView, and Ikonos has benefited the combined application of synthetic aperture radar (SAR) and optical imageries tremendously. Specifically, in case of natural calamities or disasters, decision makers can now easily use an old archived optical with a newly acquired (postdisaster) SAR image. Although the latest satellites provide the end user already georeferenced and orthorectified data products, still, registration differences exist between different data sets. These differences need to be taken care of through quick automated registration techniques before using the images in different applications. Specifically, mutual information (MI) has been utilized for the intricate SAR-optical registration problem. The computation of this metric involves estimating the joint histogram directly from image intensity values, which might have been generated from different sensor geometries and/or modalities (e.g., SAR and optical). Satellites carrying high-resolution remote sensing sensors like TerraSAR-X and Ikonos generate enormous data volume along with fine Earth observation details that might lead to failure of MI to detect correct registration parameters. In this paper, a solely histogram-based method to achieve automatic registration within TerraSAR-X and Ikonos images acquired specifically over urban areas is analyzed. Taking future sensors into a perspective, techniques like compression and segmentation for handling the enormous data volume and incompatible radiometry generated due to different SAR-optical image acquisition characteristics have been rightfully analyzed. The findings indicate that the proposed method is successful in estimating large global shifts followed by a fine refinement of registration parameters for high-resolution images acquired over dense urban areas. [J454]

"Performance Metrics for Single-Photon Laser Ranging"

Airborne laser swath mapping systems collect thousands of range measurements per second, enabling high-resolution surface mapping. Low-signal-to-noise-ratio (LSNR) detection techniques allow for implementation of

light detection and range (LIDAR) instrumentation aboard platforms with stringent power, size, and weight restrictions. The University of Florida has developed the coastal area tactical-mapping system, which is a prototype LSNR LIDAR system that is capable of single-photon laser ranging. Laser pulses of 532 nm, 3.5 ??J, and 480 ps are transmitted at 8 kHz, with the outgoing footprint split into a 10 ?? 10 array of elements. Backscattered photons are imaged back onto separate anodes of a multistop microchannel plate photomultiplier tube. A 2-GHz event timer processes returns over the array. Ranges for known targets are accumulated for repeated laser shots, and statistical analysis is applied to evaluate performance metrics that are related to minimum separation distance, bathymetric mapping depth, and atmospheric scattering. An LSNR detection paradigm based on Poisson statistics has enabled topographic target detection and shallow-water bathymetry. Quantitative results are used to draw conclusions about feature detection in topographic and bathymetric mapping scenarios. [J455]

"Range-Doppler Imaging via Forward-Backward Sparse Bayesian Learning"

We consider range-Doppler imaging via transmitting a train of probing pulses as in radar and active sonar. We show that range-Doppler imaging can be formulated as a sparse signal recovery problem and that we can use an expectation maximization based sparse Bayesian learning (EM-SBL) algorithm to achieve high resolution imaging. We also reduce the complexity of EM-SBL significantly by using an efficient forward-backward algorithm in the E step of the EM algorithm. [J456]

"TerraSAR-X Instrument Operations Rooted in the System Engineering and Calibration Project"

This paper presents the TerraSAR-X instrument operations embedded into the Instrument Operations and Calibration Segment. Special focus is on the data-take (DT) command generation. The command generation for standard DTs is discussed, and the nonnominal DT commanding is described for several examples which demonstrate the flexibility of both the TerraSAR-X instrument and the instrument operations system on-ground. [J457]

"Model-Based Estimation of Forest Canopy Height in Red and Austrian Pine Stands Using Shuttle Radar Topography Mission and Ancillary Data: A Proof-of-Concept Study"

In this paper, accurate tree stand height retrieval is demonstrated using C-band Shuttle Radar Topography Mission (SRTM) height and ancillary data. The tree height retrieval algorithm is based on modeling uniform tree stands with a single layer of randomly oriented vegetation particles. For such scattering media, the scattering phase center height, as measured by SRTM, is a function of tree height, incidence angle, and the extinction coefficient of the medium. The extinction coefficient for uniform tree stands is calculated as a function of tree height and density using allometric equations and a fractal tree model. The accuracy of the proposed algorithm is demonstrated using SRTM and TOPSAR data for 15 red pine and Austrian pine stands (TOPSAR is an airborne interferometric synthetic aperture radar). The algorithm yields root-mean-square (rms) errors of 2.5-3.6 m, which is a substantial improvement over the 6.8-8.3-m rms errors from the raw SRTM minus National Elevation Dataset Heights. [J458]

"Hermite-Rodriguez UWB Circular Arrays"

Pulsed circular arrays are collecting growing interest in radar applications such as automotives and indoor navigations. This contribution presents the analytic derivation of the space-time and energy patterns of pulsed circular arrays in terms of geometrical and electrical parameters as well as of the signal distortion produced by the antennas' response. It is shown that the field emitted by circular arrays with many elements can be represented as a summation of a practically finite set of high-order Hermite-Rodriguez waveforms, while the energy pattern is a generalized hypergeometric function. The angular and temporal resolutions are finally related, through handy formulas, to the array size, the input signals and to the antenna types. [J459]

"Closed-Form Evaluation of the Second-Order Statistical Distribution of the Interferometric Phases in Dual-Baseline SAR Systems"

Multichannel inteferometric synthetic aperture radar (InSAR) systems allow to improve the accuracy of the estimation of the height profiles of the observed scenes. Multichannel images can be acquired by using different sensors operating at different frequencies (multifrequency InSAR) or acquiring multiple images with slightly different view angles (multibaseline InSAR). The enhanced accuracy height estimation is obtained exploiting the multichannel interferometric phases and an a prioriinaccurate ground profile and requires the knowledge of the joint probability distribution of the multichannel interferometric phases, whose evaluation in a closed form is very complicated and is not found in literature. In this paper, we evaluate the analytical form of the second-order

probability density function (pdf) of dual-baseline InSAR phase interferograms, obtained from three mutually correlated interferometric images. The evaluation exploits the Gaussian model for the complex SAR images, takes into account the mutual correlation of all the images, and does not use any approximation. The closed form of the second-order joint pdf can be usefully adopted in statistical digital elevation model (DEM) estimation methods using dual-baseline SAR systems, which commonly use an approximate expression of the joint pdf of measured interferometric phases, given by the product of the marginal pdfs of each phase interferogram, obtained in the assumption of independent interferograms. The effect of this approximation is evaluated by computing the Cramer-Rao lower bounds and the mean square estimation errors obtained using the exact and the approximate model. Presented results represent the basis for the generalization to the case of more than two interferograms. [J460]

"Multistatic and MIMO Distributed ISAR for Enhanced Cross-Range Resolution of Rotating Targets"

In this paper, we present a new technique to exploit the data acquired simultaneously by multiple radar sensors carried by multiple air platforms to increase the cross-range resolution of inverse synthetic aperture radar (ISAR) images of rotating targets. This distributed ISAR technique is devised for two different cases: 1) multiple-input-multiple-output (MIMO) case with each platform carrying an active radar that transmits and receives RF waveforms and 2) multistatic case with a single platform carrying an active radar (transmitting and receiving) and the remaining platforms equipped with passive sensors (namely, receiving only). The processing chain proposed for the distributed ISAR is shown, together with the results obtained against simulated ISAR data for both the MIMO and the multistatic cases. The performance analysis shows that the proposed technique is able to provide an increase of the cross-range resolution up to the number of platforms in the multistatic case and even higher in the MIMO case, if the platforms are properly located. This is of great benefit in applications where the target rotation angle is insufficient to guarantee the desired resolution. A typical case is the imaging of ship targets with rotation induced by the sea swell structure under low sea state conditions. To make the results appealing for practical application, the performance degradation is also analyzed arising from errors in the knowledge of both the target rotation motion and the acquisition geometry. Experimental data collected by a ground-based radar operating together with a rotating platform are processed by following the presented distributed ISAR technique to validate the proposed approach. [J461]

"Estimating surface water flow speeds using time-frequency methods"

Synthetic aperture radar (SAR) image formation implicitly assumes that the backscattered returns arise from stationary isotropic targets. When objects move during the SAR integration time, signal anomalies appear that distort, displace and smear moving targets in the image. Although these anomalies degrade the image, they provide the information that allows analysis of the underlying target motion. Joint time-frequency analysis (JTFA) exploits these signal anomalies to estimate the motion of typical point targets. However, the weak, transient returns from water surface scatterers complicate standard JTFA estimates of water surface speeds. A time-frequency representation is applied based on the Capon-s spectral estimation technique that allows joint analysis of multiple azimuth lines, thereby increasing the signal-to-clutter ratio of weak scatterers. The authors compare the time-frequency estimate, employing single-phase-centre SAR data, to along-track interferometric SAR estimates of the same flow and show that both the methods produce comparable results. The authors derive the JTFA equations and estimate water surface speed for data collected at a specific imaging geometry. This study highlights the feasibility of using a single-phase-centre SAR system to determine the motion of slow moving distributed targets representative of water flow. [J462]

"Time-frequency approach to radar, sonar and seismic wave propagation with dispersion and attenuation"

In many physical situations that involve wave propagation there is dispersion and attenuation. Examples include sonar in shallow water, underground radar, seismic wave propagation, fibre optics, among many others. The author shows that phase-space methods are particularly suited to study propagation with dispersion since in such situations the velocity of propagation is frequency dependent. Depending on the situation the phase space may be time-frequency or position-wavenumber. The author derive explicit expressions for the Wigner distribution for both cases and how it evolves with time are derived. The application to the propagation of noise fields is also discussed. [J463]

"Cubic-phase function evaluation for multicomponent signals with application to SAR imaging"

A cubic-phase function evaluation technique for multicomponent frequency-modulated signals with non-overlapped components in the time-frequency (TF) plane is proposed. The proposed technique is based on the

short-time Fourier transform. Cross-terms are removed or reduced in the same manner as in the case of the TF representation called the S-method. The proposed technique is applied for visualisation of signals in time-chirp-rate plane and parameter estimation of analytical and radar signals. In addition, a procedure for focusing SAR images by using estimated parameters is proposed in order to verify obtained results. [J464]

"Inverse synthetic aperture radar image focusing using fast adaptive joint time-frequency and three-dimensional motion detection on experimental radar data"

This study presents two algorithms for enhancing the capabilities of the adaptive joint time-frequency (AJTF) approach and the three-dimensional (3D) motion detection method, respectively, on inverse synthetic aperture radar (ISAR) imaging. The first method is a modified AJTF motion compensation algorithm that is able to employ more than two prominent point scatterers for translation and rotation motion compensation, respectively. The second algorithm enhances a current 3D motion detection method. This algorithm improves the computation time for identifying 3D motion in ISAR images and selects the imaging time intervals with the least 3D motion. With these enhanced detection algorithms, the authors have the ability to distinguish the time intervals when the target undergoes smooth two-dimensional (2D) motion from those containing more chaotic 3D motion. As a result, the authors can reliably detect those time intervals where 2D target motions are predominant to form well-focused ISAR images that are used in automatic target recognition applications. [J465]

"Formulation of Doppler and cross-ambiguity processes based on delay only"

The author addresses the problem of estimating the time varying delay of a signal observed by two or more receivers, and develop accurate and computationally efficient methods for processing these signals. The effectiveness of these methods is demonstrated on signals whose parameters are consistent with airborne receivers and a stationary ground emitter. The author proposes a solution to the time varying delay problem that is based on the phase of the short time cross-correlation function. This model is based on the exact signal model in which received signal differs from the transmitted signal by a time varying delay function. The process presented is based on previous work and provides enough accuracy in the estimated delay function that accurate Doppler velocity may be estimated from the estimated delay function. Moreover, the process is computationally efficient since it is based on the conventional correlation function and does not require estimation of a cross-ambiguity function or scale cross-ambiguity function surfaces on a fine Doppler lattice. [J466]

"Mapping Subsurface Geology in Sahara Using L-Band SAR: First Results From the ALOS/PALSAR Imaging Radar"

Within the framework of Kyoto & Carbon Initiative of the Japanese Space Agency (JAXA), we used JERS-1 and ALOS/PALSAR radar images to build regional and continental scale mosaics of Sahara. The unique capability of L-band SAR to map subsurface structures in arid areas revealed previously unknown geological features: craters, faults, paleo-rivers. The latter are of particular interest for water resource detection in arid regions. [J467]

"Analytical Expressions for DG Allocation in Primary Distribution Networks"

This paper proposes analytical expressions for finding optimal size and power factor of four types of distributed generation (DG) units. DG units are sized to achieve the highest loss reduction in distribution networks. The proposed analytical expressions are based on an improvement to the method that was limited to DG type, which is capable of delivering real power only. Three other types, e.g., DG capable of delivering both real and reactive power, DG capable of delivering real power and absorbing reactive power, and DG capable of delivering reactive power only, can also be identified with their optimal size and location using the proposed method. The method has been tested in three test distribution systems with varying size and complexity and validated using exhaustive method. Results show that the proposed method requires less computation, but can lead optimal solution as verified by the exhaustive load flow method. [J468]

"Multiple-view time-frequency distribution based on the empirical mode decomposition"

This study proposes a novel, composite time-frequency distribution (TFD) constructed using a multiple-view approach. This composite TFD utilises the intrinsic mode functions (IMFs) of the empirical mode decomposition (EMD) to generate each view that are then combined using the arithmetic mean. This process has the potential to eliminate the inter-component interference generated by a quadratic TFD (QTFD), as the IMFs of the EMD are, in general, monocomponent signals. The formulation of the multiple-view TFD in the ambiguity domain results in faster computation, compared to a convolutive implementation in the time-frequency domain, and a more robust TFD in the presence of noise. The composite TFD, referred to as the EMD-TFD, was shown to

generate a heuristically more accurate representation of the distribution of time-frequency energy in a signal. It was also shown to have performance comparable to the Wigner-Ville distribution when estimating the instantaneous frequency of multiple signal components in the presence of noise. [J469]

"A Closed-Form Robust Chinese Remainder Theorem and Its Performance Analysis"

Chinese remainder theorem (CRT) reconstructs an integer from its multiple remainders that is well-known not robust in the sense that a small error in a remainder may cause a large error in the reconstruction. A robust CRT has been recently proposed when all the moduli have a common factor and the robust CRT is a searching based algorithm and no closed-from is given. In this paper, a closed-form robust CRT is proposed and a necessary and sufficient condition on the remainder errors for the closed-form robust CRT to hold is obtained. Furthermore, its performance analysis is given. It is shown that the reason for the robustness is from the remainder differential process in both searching based and our proposed closed-form robust CRT algorithms, which does no exist in the traditional CRT. We also propose an improved version of the closed-form robust CRT. Finally, we compare the performances of the traditional CRT, the searching based robust CRT and our proposed closed-form robust CRT (and its improved version) algorithms in terms of both theoretical analysis and numerical simulations. The results demonstrate that the proposed closed-form robust CRT (its improved version has the best performance) has the same performance but much simpler form than the searching based robust CRT. [J470]

"Role of avionics in trajectory-based operations"

Air Traffic Management automation systems are being developed and fielded to assist controllers in handling more aircraft and larger airspace per controller. Many of these systems are time-based and built upon predicting the aircraft trajectories as accurately as possible. Trajectories of multiple aircraft are strategically deconflicted by modifying appropriate trajectories and issuing corresponding clearances to the aircraft. However, disturbances and modeling errors will cause aircraft to deviate from their predicted trajectories and controllers will need to take action to keep trajectories free from conflict. The associated increase in workload will reduce the usefulness of these automation systems. On-board avionics can help improve the accuracy of the trajectory prediction system in three ways: (1) sharing aircraft state information to improve the performance of the ground trajectory prediction system, (2) sharing airborne prediction results and allowable minimum and maximum arrival times at key route waypoints, and, finally, (3) by applying feedback control onboard the aircraft to autonomously correct for disturbances encountered in flight. This presents an analysis of trajectory dispersion with and without airborne time of arrival control, presents an operational concept for air/ground trajectory negotiation, discusses integration with airborne merging and spacing algorithms, and raises concerns about challenges in implementing this integrated solution. [J471]

"Experimental Demonstration of a Wideband Photonic Temporal Hilbert Transformer Based on a Single Fiber Bragg Grating"

A wideband photonic temporal Hilbert transformer implemented based on a single fiber Bragg grating (FBG) is experimentally demonstrated. Two FBGs with bandwidths of 50 and 100 GHz are designed and fabricated. The use of the fabricated FBGs to perform real-time temporal Hilbert transformation of a Gaussian-like optical pulse with a bandwidth of about 12 GHz is experimentally demonstrated. [J472]

"Matching Space Antenna Deformation Electronic Compensation Strategies to Support Structure Architectures"

Radar systems are engineered to achieve a complex, yet functional, balance between diverse subsystems and competing requirements. One important trade for large deployable space radar antennas is between antenna dimensional stability and electronic signal processing for deformation compensation. This trade is first investigated for several different electronic compensation methods, and compensation capabilities are mapped into structural requirements. Second the structural requirements are translated into appropriate structural architectures. The scope of this study is limited to space radar systems, where loads causing antenna deformations differ significantly from terrestrial systems. Compensation strategies that allow structural requirements to be reduced by several orders of magnitude are identified. When considered early in the systems engineering process, the methods presented herein can be used to form a rationale for the selection and the development of a complementary combination of compensation electronics and structural architectures. [J473]

"Bearings-Only Target Motion Analysis via Instrumental Variable Estimation"

This paper deals with the instrumental variable (IV) estimation for the problem of target motion analysis from

bearing-only measurements (BO-TMA). By taking asymptotical analysis of the IV estimation, a systematic method for developing consistent IV estimate and the sufficient condition for its asymptotical normality are proposed. The asymptotical covariance of IV estimate is also derived explicitly which can be used to evaluate its performance. These results generalize the previous studies and enhance the application of the IV estimation in target tracking. Numerical examples are shown to verify the theoretical results. [J474]

"Time-frequency approach to radar detection, imaging, and classification"

One of the central problems in exploiting the radar data is the analysis of a time series. The problem at hand is how to extract the information present in the data and use it to its full potential. Traditionally, radar signals have been analysed in either the time or the frequency domain. The Fourier transform is at the heart of a wide range of techniques that are generally used in radar data analysis and processing. However, the change of frequency content with time is one of the main features we generally observe in radar data. As a result of this change of frequency content with time, radar signals belong to the class of non-stationary signals. The analysis of nonstationary signals requires a technique that extends the notion of a global frequency spectrum to a local frequency description. Joint time-frequency analysis using time-frequency transforms has improved the analysis of non-stationary signals by revealing time-varying information embedded in signals. [J475]

"Two-dimensional hermite S-method for high-resolution inverse synthetic aperture radar imaging applications"

The two-dimensional multiwindow S-method for radar imaging applications is proposed. It represents a combined technique that uses the standard S-method and the multiple windows approach based on the two-dimensional Hermite functions. The proposed method provides significant improvement of radar image concentration in comparison with the standard S-method. Also, it does not require an additional post-processing algorithm. The efficiency of the proposed method is demonstrated through various examples. [J476]

"Multiwindow S-method for instantaneous frequency estimation and its application in radar signal analysis"

A new distribution that provides high concentration in the time-frequency domain is proposed. It is based on the S-method and multiwindow approach, where different order Hermite functions are employed as multiple windows. The resulting distribution will be referred to as the multiwindow S-method. It preserves favourable properties of the standard S-method, whereas the distribution concentration is improved by using Hermite functions of just a few first orders. The proposed distribution is appropriate for radar signal analysis, as it will be proven by experimental examples. [J477]

"Focusing inverse synthetic aperture radar images with higher-order motion error using the adaptive joint-time-frequency algorithm optimised with the genetic algorithm and the particle swarm optimisation algorithm-comparison and results"

Algorithms based on the genetic algorithm (GA) and the particle swarm optimisation (PSO) algorithm were designed for focusing inverse synthetic aperture radar (ISAR) images that suffered from degradation because of Doppler smearing. These algorithms optimised the adaptive joint-time-frequency (AJTF) algorithm by replacing the exhaustive search as the primary search tool used to determine focusing parameters. The use of the PSO for ISAR image focusing is a unique application of this evolutionary search. Performance of the GA and the PSO were compared with the PSO producing the optimal results of being able to focus a 211pulse ISAR image with second-order motion error in 9 s or 24 of the cost function calculations required for an exhaustive search. The PSO algorithm was then applied to a 211pulse ISAR image with fourth-order motion error. The PSO algorithm was able to focus this image in 20 s with 33 of the cost function calculations required by the exhaustive search. This study also introduces a new method of determining basis function suitability using the fast Fourier transform. [J478]

"ISAR imaging of multiple targets using particle imaging of multiple targets using particle swarm optimisation-adaptive joint time frequency approach"

When multiple radar targets are close to each other, the returned signals from these targets are overlapped in time. Therefore by applying conventional motion compensation algorithms designed for single target, the multiple targets cannot be resolved, and individual one cannot be clearly imaged. The authors conclude that whether the radar transmits linear frequency modulated (LFM) or stepped-frequency waveform, the chirp rate in the Doppler frequency shift induced by the translation motion is only concerned with the acceleration of the target. For different targets, the chirp rates are different from each other. Based on the different chirp rates, the signals from

each target can be separated. Then a new algorithm based on the adaptive joint time frequency (AJTF) technique is proposed to separate the signals from different target in each cross-range cell. The use of the particle swarm optimisation (PSO) for multiple targets separation is a unique application of this evolutionary search. By the CLEAN technique, the number of targets need not be appointed. The simulation results confirm the efficiency of the proposed algorithm for multiple moving targets imaging. [J479]

"M3R AESA technology for extended air defence"

This focuses on the M3R Active Electronically Steered Antenna (AESA) System and will describe how this AESA is a step toward a fully digitized antenna with a receiver and an A/D-converter behind every antenna element and a full digital beam forming without using analogue sub arrays. First, it will be explained why Extended Air Defence (that is Air and Missile Defence) requires a multi-function, multi-beam radar technology: then M3R radar will be described and the M3R innovative antenna concept implemented in the M3R programme to the Thales Building Block Product Policy. The final part shows how M3R antenna architecture is a step towards fully digital radar and multi-static operating mode. [J480]

"ML Period Estimation With Application to Vital Sign Monitoring"

The real time estimation of the period of signals that are periodic over short time intervals requires fast algorithms. In this letter, the maximum likelihood (ML) period estimator is derived for a periodic signal with additive white Gaussian noise. A low complexity approximation is then proposed, and compared with the state of the art of the estimation techniques in a practical scenario for the remote estimation of human heart rate using an ultra wide band radar. [J481]

"Space-Time Coding for MIMO Radar Detection and Ranging"

Space-time coding (STC) has been shown to play a key role in the design of MIMO radars with widely spaced antennas: In particular, rank-one coding amounts to using the multiple transmit antennas as power multiplexers, while full-rank coding maximizes the transmit diversity, compromises between the two being possible through rank-deficient coding. In detecting a target at known distance and Doppler frequency, no uniformly optimum transmit policy exists, and diversity maximization turns out to be the way to go only in a (still unspecified) large signal-to-noise ratio region. The aim of this paper is to shed some light on the optimum transmit policy as the radar is to detect a target at an unknown location: To this end, at first the Cramer-Rao bounds as a function of the STC matrix are computed, and then waveform design is stated as a constrained optimization problem, where now the constraint concerns also the accuracy in target ranging, encapsulated in the Fisher Information on the range estimate. Results indicate that such accuracy constraints may visibly modify the required transmit policy and lead to rank-deficient STC also in regions where pure detection would require pursuing full transmit diversity. [J482]

"Multiple-input multiple-output radar detectors design in non-Gaussian clutter"

This study mainly deals with the problem of multiple-input multiple-output (MIMO) radar in compound-Gaussian clutter-dominated scenario with unknown covariance matrix. The general MIMO model, with widely separated sub-arrays and co-located antennas at each sub-array, is adopted. First, the signal model is developed to compound-Gaussian clutter, and then, the generalised likelihood rate test (GLRT) and Rao detectors are derived with known covariance matrix. To make the detectors fully adaptive, the secondary with signal-free data is collected to estimate the covariance. A thorough performance assessment is also given, which considers the sense with co-located antennas configuration of transmitters and receivers array. Via several numerical examples, it is shown that the derived GLRT and Rao detectors can provide excellent detection performance in spikier clutter compared with the detector, which is derived by Jian Li in Gaussian clutter. To this end, the Rao detector outperforms best. [J483]

"Improving Discrimination of Savanna Tree Species Through a Multiple-Endmember Spectral Angle Mapper Approach: Canopy-Level Analysis"

Differences in within-species phenology and structure are controlled by genetic variation, as well as topography, edaphic properties, and climatic variables across the landscape, and present important challenges to species differentiation with remote sensing. The objectives of this paper are as follows: 1) to evaluate the classification performance of a multiple-endmember spectral angle mapper (SAM) classification approach in discriminating ten common African savanna tree species and 2) to compare the results with the traditional SAM classifier based on a single endmember per species. The canopy spectral reflectance of the tree species (Acacia nigrescens, Combretum apiculatum, Combretum imberbe, Dichrostachys cinerea, Euclea natalensis, Gymnosporia buxifolia, Lonchocarpus capassa, Pterocarpus rotundifolius, Sclerocarya birrea, and Terminalia sericea) was extracted from

airborne hyperspectral imagery that was acquired using the Carnegie Airborne Observatory system over Kruger National Park, South Africa, in May 2008. This study highlights three important phenomena: 1) Intraspecies spectral variability affected the discrimination of savanna tree species with the SAM classifier; 2) the effect of intraspecies spectral variability was minimized by adopting the multiple-endmember approach, e.g., the multiple-endmember approach produced a higher overall accuracy (mean of 54.5% for 20 bootstrapped replicates) when compared to the traditional SAM (mean overall accuracy = 20.5%); and 3) targeted band selection improved the classification of savanna tree species (the mean overall percent accuracy is 57% for 20 bootstrapped replicates). Higher overall classification accuracies were observed for evergreen trees than for deciduous trees. [J484]

"The Evolution of Signal Processing [JFrom the Editor]"

Signal processing is in the midst of a major transition from a focus on classical signals in electrical engineering applications to a much wider usage devoted to the analysis of signals in a broad spectrum of science and engineering disciplines. Signal processing professionals are thus no longer limited to the traditional use of signal processing methodologies in speech, image, video, acoustics, radar, and sonar. Instead, the tools of signal processing are currently being employed to embark on new frontiers in science and technology by analysis of signals in diverse fields of astronomy, energy, finances, genomics, geosciences, privacy, security, social networks, and much more. [J485]

"Estimation of the ocean clutter rank for HF/ VHF radar space-time adaptive processing"

The rank of clutter covariance matrix is an important indicator of both the severity of the clutter scenario and the number of degrees-of-freedom required to produce effective clutter suppression. Thus, the estimation of clutter rank is an essential issue for space-time adaptive processing. The rank of ground clutter covariance matrix can be accurately predicted by the well-known Brennan's rule. Unfortunately, the similar rule for ocean clutter rank estimation has not been developed. In this paper, a formula to estimate the rank of ocean clutter covariance matrix is derived, with which the eigenspectrum structure of ocean clutter can be correctly predicted. The validity of this formula is verified by simulation results. [J486]

"Comparative study on joint data/pilot strategies for high sensitivity galileo E1 open service signal acquisition"

Global Navigation Satellite Systems (GNSS) with the ability to provide accurate positioning and timing information have become very important for many essential applications of both military and civil purposes. The upcoming European GNSS, Galileo system, foresees providing new advanced signals aiming to improve the receiver sensitivity. Towards the objective of a high sensitivity Galileo receiver architecture capable of operating anywhere at any time, the authors introduce possible joint data/pilot acquisition strategies to adapt with the problem of low received signal power in indoor environments. Analytical expressions as well as Monte Carlo simulations in indoor scenarios are presented to describe and prove the strategies improvement with respect to the conventional one currently operating inside GPS receivers. Additionally, based on the performance comparison among all the strategies, some applicable suggestions with respect to different operation modes are provided as the main contribution here. [J487]

"Backscattering and Statistical Information Fusion for Urban Area Mapping Using TerraSAR-X Data"

With the launch of the German TerraSAR-X system, a new generation of high-resolution spaceborne SAR data is available. This opens new perspectives and challenges for the automatic interpretation of urban environments. In fact, a rich information content, previously hidden or not clearly distinguishable in low resolution images such as urban structures (small buildings, vehicles, etc), is now disclosed. However, only proper approaches are able to retrieve automatically this new detailed information. This paper provides solutions for the semi-automatic interpretation and mapping of urban areas using the high resolution provided by TerraSAR-X data. Our solutions take into the increase, with the high resolution, of the visibility of some man-made structures whose scattering response has improved with the high frequency X-band SAR sensor carried by the TerraSAR-X system. They are mainly based on two steps. Firstly, we extract and describe two kinds of information: backscattering and statistical. Secondly, we propose to use information fusion techniques where intelligence has been introduced and enhanced in the way the different information is processed or treated, so that accurate mapping of urban areas could be reached. This mapping is performed through semantic categorization and retrieval of the different scene contents. Promising improvements and real progress toward automatic urban area mapping have been achieved using TerraSAR-X data. [J488]

"Wavefront curvature correction in one stationary bistatic SAR image focused via PFA"

The wavefront curvature error in one stationary bistatic synthetic aperture radar (SAR) image focused via the polar format algorithm (PFA) is analysed and a space-variant filtering method for wavefront curvature correction is proposed. The correction method presented, extends the focused scene size when using the bistatic PFA effectively. Point target simulation validates the filtering method. [J489]

"A distributed and energy-efficient framework for Neyman-Pearson detection of fluctuating signals in large-scale sensor networks"

To address the challenges inherent to a problem of practical interest-of Neyman-Pearson detection of fluctuating radar signals using wireless sensor networks, we propose in this paper a distributed and energy-efficient framework. Such framework is scalable with respect to the network size, and is able to greatly reduce the dependence on the central fusion center. It assumes a clustering infrastructure, and addresses signal processing and communications related issues arising from different layers. This framework includes a distributed scheduling protocol and a distributed routing protocol, which enable sensor nodes to make their own decisions about information transmissions, without requiring the knowledge of the network global information. In this framework, energy efficiency manifests itself at different network layers in a distributed fashion, and a balance between the detection performance and the energy efficiency is also attained. [J490]

"Coherence Factor Enhancement of Through-Wall Radar Images"

The coherence factor (CF), defined as the ratio of coherent power to incoherent power received by an array of sensors for a given point in an image scene, is applied to through-wall image processing. It is shown that CF filtering reduces clutter and increases clarity and uniformity in the image by suppressing the low-coherence features. It is also shown that through-wall propagation degrades the CF, thereby enabling its use as a quantitative metric for autofocus and image correction algorithms. [J491]

"Sentinel-1 radar mission: Status and performance"

The ESA Sentinels constitute the first series of operational satellites responding to the Earth Observation needs of the EU-ESA Global Monitoring for Environment and Security (GMES) programme. The GMES space component relies on existing and planned space assets as well as on new complementary developments by ESA. This describes the Sentinel-1 mission, as imaging synthetic aperture radar (SAR) satellite constellation at C-band. It provides an overview of mission requirements, its applications and the technical concepts for the system. [J492]

"Correction: Application of passive surveillance radar system using cell phone base station illuminators"

{no data available} [J493]

"An Integrated 0.6-4.6 GHz, 5-7 GHz, 10-14 GHz, and 20-28 GHz Frequency Synthesizer for Software-Defined Radio Applications"

We present an integrated frequency synthesizer which is able to provide in-phase/quadrature phase signal over the frequency bands 0.6-4.6 GHz, 5-7 GHz, 10-14 GHz, and in-phase signal over 20-28 GHz for software-defined radio applications. An integrated voltage-controlled oscillator (VCO) with 34% tuning range and a set of high-speed dividers are used to accomplish all the frequencies. To achieve a wide tuning range while keeping a low gain and a low phase noise, the VCO employs digitally controlled sub-bands. The measured PLL phase noise is-108 dBc/Hz, -121 dBc/Hz, and -135 dBc/Hz at 1 MHz offset for 24 GHz, 4 GHz, and 700 MHz, respectively. Fabricated in a 0.25 μm SiGe BiCMOS process, the synthesizer occupies a chip area of 4.8 mm2. The synthesizer was optimized for reconfigurable base station applications, but can also be used for cognitive radio, radar systems, satellite communication, and high-speed digital clock generation. [J494]

"Performance analysis of MUSIC for non-circular signals in the presence of mutual coupling"

The mutual coupling effect in practical arrays is hard to eliminate completely, and such effect brings a deterministic bias into the direction-of-arrival (DOA) estimates for non-circular signals. The bias is analysed in this study and closed-form expressions for the biases in uniform linear arrays (ULA) and general linear arrays (GLA) are given. Numerical examples are carried out to verify the correctness of the theoretical biases in various signal environments. [J495]

"Matched-filter-based low-complexity correlator for simultaneously acquiring global positioning

system satellites"

In the global positioning system (GPS), code acquisition involves searching all possible code-phase candidates for the existence of satellites. Although code-phase search using a matched filter (MF) is efficient for one satellite, computational complexity increases if numerous satellites have to be searched simultaneously. In this study, a low-complexity routing correlator (RC) that can acquire multiple satellites is proposed. The rationale behind the RC is to fully utilise partial correlation values, which are by-products during the code acquisition process. Traditionally, each satellite's partial correlation values are instantly summed to decide its existence only. The partial correlation values in the RC, in contrast, can be shared to derive the correlation results of multiple satellites. By sharing and reusing these temporary correlation values, the proposed RC can simultaneously tackle multiple satellites and output the corresponding correlation results, as if there are multiple MFs operating at the same time. In addition, using the RC will not degrade the signal-to-noise ratio. A low-complexity acquisition unit employing the RC for GPS coarse/acquisition (C/A) codes is demonstrated, and the simulation results show that the computational complexity is reduced by about 94', compared to the conventional MFs. [J496]

"Field-to-Wire Coupling in an Electrically Large Cavity: A Semianalytic Solution"

This paper proposes a semianalytic solution to the problem of high frequency coupling on a wire running in electrically large enclosures. This model is basically derived from the transmission-line (TL) theory in which the electromagnetic (EM) environment, represented as a random plane-wave spectrum, is characterized by its statistical parameters. The results are compared to those obtained by randomly generating elementary plane-wave samples and numerically calculating their EM coupling through a TL model. [J497]

"Global navigation satellite system signal acquisition using multi-bit codes and a multi-layer search strategy"

The acquisition of spreading sequences is a crucial task in spread-spectrum communication and ranging receivers. An acquisition method by utilising a multi-bit local code to acquire spread-spectrum signals is presented. The local code design problem towards multiple-support, bounded sidelobe, bounded cross-correlation, balance and bounded variance is formulated and solved through a quadratic programming. Based on the local codes, a multi-layer acquisition approach is devised to yield an overall improvement in acquisition speed. The performance tradeoffs in the code design stage and code acquisition stage are described. Applications of the proposed method to acquire global positioning system and Galileo codes are provided. It is shown that the proposed scheme can effectively reduce the mean acquisition time in comparison with the traditional search approach. [J498]

"Adaptive detection of a signal with angle uncertainty"

This study deals with adaptive detection of a signal with unknown complex amplitude and whose steering vector presents angle uncertainties. The background environment is assumed homogeneous and Gaussian with unknown covariance matrix. At the design stage, the authors devise a class of robust receivers accounting for the aforementioned uncertainty. To this end, the authors prove that the maximisation of the concentrated likelihood function over the phase parameter shares a hidden convexity property. Specifically, exploiting some recent results concerning trigonometric polynomials, the authors formulate the apparently non-convex maximisation over the phase as a semidefinite programming (SDP) convex optimisation problem. Then, the authors show that the receivers of the class (but for one) exhibit a bounded-constant false alarm rate (bounded-CFAR) behaviour and derive lower and upper bounds for both the false alarm and the detection performance. At the analysis stage, the authors assess the performance of the new receivers in comparison with some classic detectors available in open literature. [J499]

"Adaptive two-step calibration for high resolution and wide-swath SAR imaging"

In this study, the authors focus on the channel calibration for digital beam forming (DBF) synthetic aperture radar (SAR) imagery. Incorporated with DBF processing, multi-channel SAR is promising in high-resolution and wide-swath (HRWS) imaging. It coherently combines recorded multi-channel signals to overcome the spectrum ambiguity. However, the mismatch between channels and baseline errors phase should be compensated before the processing. In this study, the authors propose a novel calibration for DBF SAR imagery by making use of the orthognality between signal subspace and noise subspace. Based on that the imbalance is uncoupled in range and azimuth, the calibration has two steps: range calibration and azimuth calibration. The mismatch in range is estimated by an interpolation in time domain which is applicable in the presence of the Doppler ambiguity. The azimuth calibration is incorporated with the post-Doppler beam forming processing, which estimates the element error caused by baseline errors and channel imbalance. Real data are used to demonstrate the performance of Doppler ambiguity suppression after our calibration. The results confirm the validity of the approach. [J500]

"Estimation of two-dimensional direction-of-arrival for uncorrelated and coherent signals with low complexity"

In this study, a low complexity two-dimensional direction-of-arrival (2-D DOA) estimation method is proposed with uniform rectangular array (URA) when uncorrelated and coherent signals coexist. By using a new method of modified estimation of signal parameters via rotation invariance techniques (ESPRIT), the DOAs of uncorrelated signals are first estimated. Afterwards, the contributions of uncorrelated signals are eliminated, and then a new Toeplitz matrix without the information of uncorrelated signals is constructed. Using the product of the Toeplitz matrix and its conjugate transpose matrix, the remaining coherent signals can be resolved. With the two-step processing, the proposed method can resolve more signals with low computational complexity. Simulation results demonstrate the effectiveness and efficiency of the proposed method. The Cramer-Rao bound (CRB) for this signal scenario is also derived. [J501]

"Detection and mitigation of wind turbine clutter in C-band meteorological radar"

Wind farm installations that are near radar systems cause clutter returns that can affect the normal operation of the radar. Wind turbines provoke clutter reflectivity returns with unpredictable Doppler spreads that are not easily minimised. In this study, the authors focus on the mitigation of wind turbine clutter (WTC) for C-band weather radar. The proposed detection technique is applicable when using the spotlight operation mode during radar data gathering. This means that the dwell time must be long enough to observe certain statistics that allow for the detection of wind turbines. This specific operation mode can be used between normal radar scans. The detection technique can be applied before or after real rain data are added to WTC, with different results. Our mitigation technique uses the information from bins adjacent to WTC detections. The authors test this algorithm with real data from wind farms in rainy weather. The results are encouraging, because the absolute errors, both in reflectivity and in velocity measurements, are significantly reduced. [J502]

"Data fusion for underwater target tracking"

Underwater manoeuvring target rarely tracked using bearings-only measurements available from Hull mounted array (HA) without a proper manoeuvre by the observer. This problem is solved by administering data fusion techniques on bearings available from towed array and HA. Song and Speyer's and Galkowski and Islam's modified gain bearings only extended Kalman filter is exploited for estimation of target motion parameters. Online pre-processing is carried out to reduce the amplitude of the noise, compute the estimated bearings if the bearing measurement is not available and to find out variance of the noisy measurement which is used in Kalman filter. The spurious measurements are made invalid. The performance evaluation of the algorithms is done in Monte-Carlo simulation and results obtained for two typical geometries are presented. [J503]

"New algorithm for fast direction-of-arrival estimation using the shrinking signal subspace and the noise pseudo-eigenvector"

This study presents a new direction-of-arrival (DOA) estimation technique with application to the uniform linear sensor array for rapidly varying signals in the uncorrelated or coherent case. Unlike the conventional subspace-based algorithms, it need not form the covariance matrix using a block of the array data, a complicated computational burden and a prior knowledge of the number of incoming signals. This approach is based on the technologies of the shrinking signal subspace and the noise pseudo-eigenvector. In contrast with Kim's method, our purposed algorithm can improve its performance of resolution capabilities but requires less computational complexity. Computer simulation results that demonstrate the resolution performance of the proposed algorithm are included. Since the algorithm is simple and can maintain resolution capabilities as compared to Kim's method, it may be used on its own to provide a wider application prospect in real-time DOA estimation or be used as good initialisation for more complex and more high-resolution DOA algorithms. [J504]

"Hybrid direct data domain sigma-delta space-time adaptive processing algorithm in non-homogeneous clutter"

The need to deal with non-homogeneous clutter has driven much of the recent research in space-time adaptive processing (STAP). An extension of the low-complexity, sigma-delta (ΣΔ) algorithm incorporating the direct data domain (D3) processing is presented. The new algorithm is practical and improves target detection in nonhomogeneous clutter environments. The algorithm employs a hybrid approach, combining D3processing with the more traditional statistical approach, thereby obtaining advantages of both. First, a modified D3algorithm, which maximises signal-to-interference-plus-noise ratio (SINR), is presented. Then this D3algorithm is used as an adaptive transformer to create sum (Σ) and difference (Δ) beams. The residual interference after the D3processing is further cancelled by ΣΔ STAP. The proposed hybrid algorithm using D3-ΣΔ STAP is tested in

nonhomogeneous clutter modelled using spherically invariant random variables (SIRV) and artificially injected discrete interferers. Performance of the proposed methods is compared with those of traditional statistical approaches, illustrating significant benefits of hybrid processing in non-homogeneous scenarios. [J505]

"Generalisation of inverse synthetic aperture radar autofocusing methods based on the minimisation of the Renyi entropy"

In order to obtain focused inverse synthetic aperture radar (ISAR) images, an accurate translational motion compensation is required. The phase adjustment step corresponds to fine compensation and must be properly designed. The authors introduce the Renyi entropy for autofocusing ISAR images. The Renyi entropy of order α is a generalisation of the standard Shannon entropy. When α tends to be the unity, the Renyi entropy tends to be the Shannon entropy. Here, we demonstrate that minimising the Renyi entropy for α = 2 is equivalent to maximising the contrast for ISAR autofocusing. Furthermore, it is also shown that maximising the peak value is equivalent to minimising the Renyi entropy for α tending to infinity. On the other hand, the authors propose to minimise the Renyi entropy with α = 0.5 to reconstruct an accurate ISAR image. Simulated data have been used to verify that, in terms of mean squared error, the proposed method with α =0.5 outperforms other autofocusing algorithms such as the method based on contrast maximisation or the one based on the minimisation of the standard Shannon entropy. The method has also been applied to real data. [J506]

"High-speed multi-target detection with narrowband radar"

High-speed multi-target detection is a challenging problem in radar applications. Typically, targets with high speed go through several range cells in the observation period, which makes it more difficult to obtain each target's power coherently accumulated for target detection. In this study, novel multi-target detection with a narrowband radar system is proposed. In order to remove range migration and obtain coherent integration of the target energy, the Keystone transform is applied to the moving targets. However, because of the high target velocity and the low radar pulse repetition frequency phase ambiguity will occur, so the range migration will not be corrected properly. Then the phase ambiguity function of the kth target is compensated, and the envelope of the kth target concentrates in a certain range cell. Following by frequency modulation rate search a quadratic phase term is compensated, and the signal energy is finally coherently accumulated by FT analysis. The target is detected if the ratio of peak value to noise is higher than a predetermined threshold. For target detection in low signal-to-noise ratio (SNR), the Clean technique is applied. The proposed algorithm is verified by simulation and raw radar data results. [J507]

"Corrections to "An Array Error Estimation Method for Constellation SAR Systems" [JOct 10 731-735]"

In the above titled paper (ibid., vol. 7, no. 4, pp. 731-735, Oct. 10), there are errors in Section IV which are corrected here. [J508]

"Image Autocoregistration and Interferogram Estimation Using Extended COMET-EXIP Method"

In this paper, an extended COvariance Matching Estimation Techniques-Extend Invariance Principle (COMET-EXIP) method is proposed to estimate interferometric synthetic aperture radar or interferometric synthetic aperture sonar (InSAS) interferometric phase in the presence of large coregistration errors, even up to one pixel. First, the extended COMET-EXIP method is presented for the application of joint-pixel-model-based interferogram estimation, through choosing a novel "unstructured model" in terms of the parameters to be estimated and decoupling the interesting parameters from the uninteresting "nuisance parameters." Then, a fast algorithm of COMET-EXIP is proposed for the interferometric phase estimation. Finally, the ambiguity problem of the COMET-EXIP method is solved without introducing performance degradation. The simulated data and real data from the trial InSAS and X-SAR are used to verify the validity of the method. The results show that the method is robust for a wide range of signal-to-noise ratio and has a good performance on both fringe preserving and noise suppressing. In addition, the same computational speed level of the proposed method as that of the pivoting mean filtering is very attractive. [J509]

"Tensor Algebra and Multidimensional Harmonic Retrieval in Signal Processing for MIMO Radar"

Detection and estimation problems in multiple-input multiple-output (MIMO) radar have recently drawn considerable interest in the signal processing community. Radar has long been a staple of signal processing, and MIMO radar presents challenges and opportunities in adapting classical radar imaging tools and developing new ones. Our aim in this article is to showcase the potential of tensor algebra and multidimensional harmonic retrieval (HR) in signal processing for MIMO radar. Tensor algebra and multidimensional HR are relatively mature

topics, albeit still on the fringes of signal processing research. We show they are in fact central for target localization in a variety of pertinent MIMO radar scenarios. Tensor algebra naturally comes into play when the coherent processing interval comprises multiple pulses, or multiple transmit and receive subarrays are used (multistatic configuration). Multidimensional harmonic structure emerges for far-field uniform linear transmit/receive array configurations, also taking into account Doppler shift; and hybrid models arise in-between. This viewpoint opens the door for the application and further development of powerful algorithms and identifiability results for MIMO radar. Compared to the classical radar-imaging-based methods such as Capon or MUSIC, these algebraic techniques yield improved performance, especially for closely spaced targets, at modest complexity. [J510]

"Cooperative Vehicular Safety Applications"

The past decade witnessed active safety systems such as vehicle stability control (VSC) rapidly change the automotive electronic landscape by complementing passive safety systems such as seat belts and air bags. Most automotive original equipment manufacturers (OEMs) offer laser-based or radar-based adaptive cruise control (ACC) or precrash systems (PCSs). ACC employs forward-looking sensors for longitudinal control of the vehicle through brake and throttle actuation. PCSs additionally utilize rear-looking sensors and driver-recognition cameras to prepare the vehicle's cabin for an imminent collision by seat belt pretensioning and head-restraint repositioning. Similarly, OEMs are releasing lateral control systems such as lane-keeping assistants (LKAs) or lane-departure warnings (LDWs), which use computer vision to detect the vehicle's orientation relative to lane markings and provide feedback to the driver through audible, visual, or haptic signals. [J511]

"Introduction to the Issue on Enabling Technologies for Digital Optical Communication Systems"

This issue aims at providing a diverse coverage of the current state of research in digital optical communication technologies, ranging all the way from deep-space laser communications to terrestrial fiber-optic transport, packet, and access networks to digital optical communications for computer interconnects and on-chip integration. [J512]

"Ranging of UHF RFID Tag Using Stepped Frequency Read-Out"

This paper presents a phase-based method for obtaining the distance of an RFID tag with unknown properties. The tag's response is measured by the reader at several discrete frequencies at the threshold power of the tag. The dispersive properties of the modulated reflection coefficient of the tag are estimated from the measured power sensitivity and their effect is compensated in the distance estimation. The method is derived using a simple theoretical model for the tag and the performance of the method is experimentally verified at 860 MHz. [J513]

"Clutter suppression for airborne nonsidelooking radar using ERCB-STAP algorithm"

Clutter suppression for airborne non-sidelooking radar is a challenging problem due to the range-dependent clutter. In this study, an algorithm combining elevation robust Capon beamforming (ERCB) and two-dimensional azimuth-Doppler space-time adaptive processing (STAP) is presented to realise clutter suppression for airborne non-sidelooking radar. The presented algorithm can place range-dependent nulls to eliminate the range-dependent clutter and the residual range-independent clutter can be suppressed by two-dimensional azimuth-Doppler STAP methods. Numerical examples are given to demonstrate the effectiveness of the presented algorithm. [J514]

"Beacon-Aided Adaptive Localization of Noise Sources Aboard a Pass-By Railcar Using a Trackside Microphone Array"

A new adaptive "beamforming" signal-processing algorithm is developed to locate the loudest noise sources aboard a railcar that passes by a trackside immobile microphone array. This proposed microphone-array beamformer tracks the railcar's spatial movement with the aid of two inaudible acoustic beacons placed aboard the railcar. The proposed scheme then localizes the noise sources with reference to the railcar's coordinates. No auxiliary infrastructure (e.g., no radar or video camera) is needed besides the onboard beacons. Monte Carlo simulations and anechoic chamber experiments verify the efficacy of the proposed scheme. [J515]

"Two-Dimensional Oversampled DFT Modulated Filter Banks and Critically Sampled Modified DFT Modulated Filter Banks"

This paper investigates two-dimensional (2D) 2 oversampled DFT modulated filter banks and 2D critically sampled modified DFT (MDFT) modulated filter banks as well as their design. The structure and perfect

reconstruction (PR) condition of 2D 2Ч oversampled DFT modulated filter banks are presented in terms of the polyphase decompositions of prototype filters (PFs). In the double-prototype case, the part solutions of the PR condition are parameterized by imposing the 2D two-channel lifting structure on each pair of the polyphase components of analysis and synthesis PFs. Based on the parametric structure, the analysis and synthesis PFs are separately designed by constrained quadratic programs. The obtained filter banks are of structurally PR. Moreover, 2D critically sampled MDFT modulated filter banks are proposed. It is proved that 2D critically sampled PR MDFT modulated filter banks can be rebuilt from 2D 2 oversampled PR DFT modulated filter banks when the decimation matrices satisfy a permissible condition and the analysis and synthesis PFs are identical and symmetric with respect to the origin. A numerical algorithm is given to design 2D critically sampled PR MDFT modulated filter banks and the obtained filter banks are of numerically PR. [J516]

"Non-parametric Bayesian super-resolution"

Super-resolution of signals and images can improve the automatic detection and recognition of objects of interest. However, the uncertainty associated with this process is not often taken into consideration. This is important because the processing of noisy signals can result in spurious estimates of the scene content. This study reviews a variety of super-resolution techniques and presents two non-parametric Bayesian super-resolution algorithms that not only take uncertainty into account, but also retain knowledge about the output uncertainty in the form of a full probability distribution. One of the two Bayesian techniques is based on an analytical calculation re-interpreted as super-resolution, and the other is a novel numerical algorithm. Although the algorithms are presented as stand-alone techniques for image analysis, such Bayesian super-resolution algorithms can increase automatic target recognition performance over standard super-resolution. [J517]

"Predicting Small Target Detection Performance of Low-SNR Airborne Lidar"

Recent technological advances in the performance of small micro-lasers and multi-channel multi-event photo-detectors have enabled the development of experimental airborne lidar (light detection and ranging) systems based on a low-SNR (LSNR) paradigm. Due to dense point spacing (tens of points per square meter) and sub-decimeter range resolution, LSNR lidar can likely enable detection of meter-scale targets that would go unnoticed by traditional lidar technology. Small vehicle obstructions and other similar targets in the beach and littoral zones are of particular interest, because of LSNR lidar's applicability to the near-shore environment and the general desire to improve detection of antivehicle and antipersonnel obstacles in the coastal zone. A target detection procedure is presented that exploits the detailed information available from LSNR lidar data while diminishing the effect of spurious noise events. Consideration is given to detection in both topographic and bathymetric scenarios. Data sets for target detection analysis are supplied by a numerical sensor simulator developed at the University of Florida. Target detection performance is evaluated as a function of environmental characteristics, such as water clarity and depth, and system parameters, specifically transmitted pulse energy and laser pulse repetition frequency. Analysis of results with regards to consideration for future system design is discussed. [J518]

"Adaptive Target Detection With Application to Through-the-Wall Radar Imaging"

An adaptive detection scheme is proposed for radar imaging. The proposed detector is a postprocessing scheme derived for one-, two-, and three-dimensional data, and applied to through-the-wall imaging using synthetic aperture radar. The target image statistics depend on the target three-dimensional orientation and position. The statistics can also vary with the standoff distance of the imaging system because of the change in the corresponding scene image resolution. We propose an iterative target detection scheme for the cases in which no or partial a priori knowledge of the target image statistics is available. Properties of the proposed scheme, such as conditions of convergence and optimal configurations are introduced. The detector performance is examined under synthetic and real data. The latter is obtained using a synthetic aperture through-the-wall radar indoor imaging scanner implementing wideband delay and sum beamforming. [J519]

"Harry Rowe Mimno Award"

Thank you very much for the Harry Rowe Mimno Award that the AES Society recently gave me. The $1000 check accompanying the award was appreciated as well. I also thank you for IEEE's publication of my Case History of Radar in the year 2006. Those were two important recognitions of a major research effort that I developed during the years 1960-1961, almost half a century ago. [J520]

"Foreword"

"… to see what happened, why it happened, the sources of resistance, the things that slowed it down, the actions taken to overcome or circumvent obstacles and roadblocks, why it was turned down at first, arguments

used…to place ;1 in developmcnt, and arguments used agains! it by its opponents…" [J521]

"Optimisation of complete complementary codes in MIMO radar system"

The novelty of multiple-input multiple-output (MIMO) radar is to improve the performance of radar utilising spatial diversity and waveform diversity. Proposed is the optimisation design of complete complementary sequence (CC-S) for MIMO radar based on channel capacity with the clutter statistical properties known. The method obtains the optimised CC-S through maximising the channel capacity of MIMO radar. The result shows that the optimised CC-S is a function of the clutter covariance matrix. Finally, the method from the information theoretical point of view is verified. [J522]

"Frequency-Domain Bistatic SAR Processing for Spaceborne/Airborne Configuration"

This paper focuses on the bistatic synthetic aperture radar (BiSAR) signal processing in the spaceborne/airborne configuration. Due to the extreme differences in platform velocities and slant ranges, the airborne system operates in the inverse sliding spotlight mode, while the spaceborne system works in the sliding spotlight mode to achieve a tradeoff between the azimuth scene size and azimuth resolution. Such a mode is generally called double sliding spotlight mode. In this configuration, the echoed signal has two characteristics. Firstly, both transmitter and receiver have very short synthetic aperture times. Secondly, the airborne platform operates with wide squint difference, while the spaceborne platform works in the small squint case. According to these two features, we use different Taylor expansions to address the slant range histories of transmitter and receiver. Based on the presented model, a two-dimensional space-variant bistatic point target reference spectrum (BPTRS) is derived. Furthermore, we linearize the BPTRS to derive the transfer function of the baseband scene. From the transfer function, the signal features of the spaceborne/airborne configuration become very clear. Using the transfer function, the two-dimensional inverse scaled Fourier transform (ISFT) is used to focus the bistatic signal in the spaceborne/airborne configuration. [J523]

"Estimation Method for InSAR Interferometric Phase Based on Generalized Correlation Steering Vector"

We propose a new method, based on the generalized correlation steering vector, to estimate synthetic aperture radar interferometry (InSAR) interferometric phase. In this method the generalized correlation steering vector with a large coregistration error is determined according to the joint data vector. The generalized correlation steering vector is then used to estimate the InSAR interferometric phase. The method can simultaneously auto-coregister the synthetic aperture radar (SAR) images and reduce the interferometric phase noise. Theoretical analysis and computer simulation results show that the method can provide an accurate estimate of the terrain interferometric phase (interferogram), even if the coregistration error reaches one pixel. [J524]

"SAR Processors Based on Signal or Interference Subspace Detector"

In this paper, we present a new synthetic aperture radar (SAR) processor relying on subspace detectors. The scattering pattern of the constituent element of the man-made target (MMT) to detect is used to improve the detection capabilities. In the particular case of foliage penetration (FOPEN), we propose to reduce the probability of false alarms by considering the scattering pattern of almost vertical trunks (modeled here as dielectric cylinders). New subspace detectors are derived to look for either an interference or a target element in a noisy environment. A new processor based on these subspace detectors is successively applied to simulated data. In addition, results obtained with real data reveal a significant improvement in the detection capabilities both in comparison with a classical SAR processor and with the subspace signal detector SAR (SSDSAR) processor (without interference model). [J525]

"Interference Cancellation and Signal Direction Finding with Low Complexity"

We propose a novel beamforming algorithm for a three-element system that suppresses an interference signal while still being able to measure a target's interferometer phases. Unlike most direction-of-arrival (DOA) estimation algorithms, our algorithm does not use a grid search. Instead the estimates result from a closed-form solution, a great advantage in time-sensitive applications. The derivation of the algorithm is presented, and its statistical performance is examined with simulations. Additionally, our numerical results demonstrate that our algorithm is capable of achieving more reliable DOA estimates than those found with the well-known multiple signal classification (MUSIC) algorithm. Finally, a radar signal processing example is presented. [J526]

"Light-Stripe-Projection-Based Target Position Designation for Intelligent Parking-Assist System"

This paper proposes a novel light-stripe-projection-based target position-designation method for an intelligent

parking assist system, providing an economical free-space-based target position-designation method for poorly lit indoor parking spaces without degradation of the external appearance when integrated into a vehicle's body. The proposed method can be applied by adding a low-cost light plane projector to existing backward-parking cameras. Light stripe features are detected by the difference between an image with the light plane projector on and off. Three-dimensional information of the parking area is reconstructed using the light-stripe-projection theory. By orientation normalization and depth-map construction, free spaces are detected, and the nearest is selected as the target position. Experimental results show that the proposed method can successfully designate the target position, in spite of poor lighting conditions and the black reflective surface of adjacently parked vehicles. [J527]

"A new all-digital time differential gamma -gamma angular correlation spectrometer"

A new digital time differential perturbed angular correlation spectrometer, designed to measure the energy of and coincidence time between correlated detector signals, here correlated gamma photons, is presented. The system overcomes limitations of earlier digital approaches and features improved performance and handling. By consequently separating the data recording and evaluation, it permits the simultaneous measurement of decays with several gamma -ray cascades at once and avoids the necessity of premeasurement configuration. Tests showed that the spectrometer reaches a time resolution of 460 ps [using a 60Cosample and Lu1.8Y0.2SiO5:Ce(LYSO) scintillators, otherwise better than 100 ps], an energy resolution that is equivalent to the limit of the used scintillation material, and a processing capability of more than 200 000 gamma quanta per detector and second. Other possible applications of the presented methods include nuclear spectroscopy, positron emission tomography, time of flight studies, lidar, and radar. [J528]

"Simultaneous Observations and Analysis of Severe Storms Using Polarimetric X-Band SAR and Ground-Based Weather Radar"

Recent advances in synthetic aperture radar (SAR) technology have revived meteorological applications with this type of radar. SARs are designed for surface imaging, but now that several X-band multipolarization SAR satellites are in orbit, the attenuation and backscatter caused by precipitation can be better studied. The results presented here demonstrate some of the possibilities by analyzing observations from dual-polarization (HH, VV) TerraSAR-X (TSX) acquisitions over central Florida surrounding severe storms in August 2008. Simultaneous to the SAR acquisitions, WSR-88D ground weather radars in Melbourne and Tampa Bay, FL, collected reflectivity and radial velocity data; the observed strong precipitation cells from convective storms are colocated with severe attenuation in the corresponding SAR images. The observations from SAR measurements are explained quantitatively by converting ground radar reflectivity into spaceborne radar attenuation via a theoretical model. In addition, polarization analysis comparing the SAR image to two additional TSX acquisitions 11 days apart and without rain provides an indication of storm-induced propagation effects on X-band SAR. Specifically, the copolar ratio Z_dr and the copolar correlation differences exhibit behavior that is better explained by the precipitation impact versus surface changes. Multiple regions with varying ground cover, including urban, and storm characteristics are analyzed to highlight the complexity of meteorological research using SAR while revealing a potential use of the technology to investigate the storm structure. [J529]

"A Marked Point Process for Modeling Lidar Waveforms"

Lidar waveforms are 1-D signals representing a train of echoes caused by reflections at different targets. Modeling these echoes with the appropriate parametric function is useful to retrieve information about the physical characteristics of the targets. This paper presents a new probabilistic model based upon a marked point process which reconstructs the echoes from recorded discrete waveforms as a sequence ofparametric curves. Such an approach allows to fit each mode of a waveform with the most suitable function and to deal with both, symmetric and asymmetric, echoes. The model takes into account a data term, which measures the coherence between the models and the waveforms, and a regularization term, which introduces prior knowledge on the reconstructed signal. The exploration of the associated configuration space is performed by a reversible jump Markov chain Monte Carlo (RJMCMC) sampler coupled with simulated annealing. Experiments with different kinds of lidar signals, especially from urban scenes, show the high potential of the proposed approach. To further demonstrate the advantages of the suggested method, actual laser scans are classified and the results are reported. [J530]

"Tunable SIW cavity backed active antenna oscillator"

A substrate integrated waveguide (SIW) cavity backed active slot antenna oscillator is proposed, the operation frequency of which can be tuned by means of a properly connected varactor. The cavity backed structure permits overcoming potential problems such as heat dissipation and unwanted surface wave modes in large array

implementations, and may provide better phase noise performance. The use of SIW technology permits a cost-effective fabrication process and simple implementation at millimetre-wave frequency, for radar and communication applications. Full-wave FEM-based analysis is used for the design of the radiating structure, while harmonic balance and transient simulations are employed in the design of the active antenna oscillator and in the study of the stability of its steady-state solutions. Tunable active antenna prototypes have been implemented and measured. [J531]

"RF Sensor Networks for Device-Free Localization: Measurements, Models, and Algorithms"

In this paper, we discuss the emerging application of device-free localization (DFL) using wireless sensor networks, which find people and objects in the environment in which the network is deployed, even in buildings and through walls. These networks are termed "RF sensor networks" because the wireless network itself is the sensor, using radio-frequency (RF) signals to probe the deployment area. DFL in cluttered multipath environments has been shown to be feasible, and in fact benefits from rich multipath channels. We describe modalities of measurements made by RF sensors, the statistical models which relate a person's position to channel measurements, and describe research progress in this area. [J532]

"AESA upgrade option for Eurofighter Captor Radar"

The Euroradar Consortium has successfully developed and demonstrated an Active Electronically Scanned Array (AESA) technology upgrade for the Eurofighter Typhoon Captor Radar. This technology demonstrator, designated Captor Active Electronically Scanned Array Radar (CAESAR), enables E-scan capability to be fully exploited by the existing Captor radar, while retaining all features and capabilities of the original system. Advanced waveforms, designed and optimized for electronically-scanned radar systems, have been evaluated in recent CAESAR flight trials. Production of the CAESAR system will address repackaging of the AESA and associated components to minimize mass and volume, reduce cost, and ensure ease of supportability. CAESAR has demonstrated that AESA benefits can be provided within the existing Captor framework, enhancing sensor capability while retaining existing Eurofighter Typhoon interfaces. [J533]

"Joint DOD-DOA estimation using combined ESPRIT-MUSIC approach in MIMO radar"

A new method for joint direction of arrival (DOA)-direction of departure (DOD) estimation in bistatic MIMO radar is proposed. This method, based on the decomposition of the 2D direction finding into double 1D direction finding, uses the ESPRIT method to estimate the DOD and the Root-MUSIC for the DOA estimation. Some simulation results are presented to verify the efficiency of this approach. [J534]

"Wireless wises up with smart antennas"

The concept of smart antennas (also known as adaptive antennas) is not new. However, until recent years, their cost has prevented their use in commercial systems. Smart antennas are antenna arrays with smart signal processing algorithms used to identify spatial signal signature. Smart antenna techniques are used notably in acoustic signal processing, radar, radio telescopes, and cellular systems. [J535]

"Robust low-angle estimation by an array radar"

One of the origins of error in the angle of arrival estimation of a signal is the response of the ground to the reflected waves from the target. In low-height target situations, this phenomenon can be so harrowing that it may result in much more error than thermal noise. In this article, two methods of fixed beam and double null are used as preliminary techniques to overcome the problem of low-altitude target angle estimation, and the optimum weights for beam-forming array radar are proposed. These beam-forming methods enable the radar to estimate the target angle precisely without the exact knowledge of the surface slope, whereas they are robust against diffuse and specular ground reflection components. [J536]

"Sense & Avoid capability development challenges"

Unmanned Aircraft Systems will require a Sense & Avoid function to protect against collisions with other aircraft as well as various other hazards. Architectural alternatives in the distributions of functionality between aircraft and a ground control station make the development of requirements and standards more complex. A broad variety of candidate sensor technologies has the potential to fulfill the surveillance portion of the system. This explores the capabilities and limitations of these technologies, and suggests deploying combinations of technologies to capitalize upon their respective strengths. A discussion of algorithmic requirements draws upon the experience of the Traffic Alert and Collision Avoidance System (TCAS) in the airspace. Differences and challenges in implementing an algorithm for a UAS are discussed. The broad range of UAS aerodynamic

characteristics complicate the process of standardizing an algorithm for Sense & Avoid. In order to build a safety case supporting the certification of a UAS, its performance must be thoroughly evaluated. In the case of Sense & Avoid, flight testing cannot be sufficiently thorough, and instead, the simulation of the system for large numbers of aircraft encounters is recommended. This discusses the considerations in performing such simulations, and in modeling various components of the system and of the potential encounter geometries. Unlike TCAS, an encounter model cannot be constructed solely from observed data, as UAS are not yet performing the desired uses. The Sense & Avoid work within the RTCA SC-203 standards committee is described. [J537]

"Components and technologies for T/R modules"

This presents new developments and perspectives in Phased Arrays Radars and Electronic Warfare for the next generations of T/R modules (medium/long term), in order to decrease the mass production cost, while increasing the level of performance and reliability. In terms of physical architecture, even if the brick concept is more current at mid-term, the tile concept is investigated for conformal and/or multifunction phased array antennas: a 3-dimensional module will lead to a drastic reduction of size and weight of the antennas. MMICs are always the key components, with evolution toward multifunction chips, and new processes like GaN, SiGe, MEMS power switches. Concerning the packaging, a technological roadmap indicates different capabilities: 1) thick film multilayer ceramic circuits, 2) co-fired ceramics based on LTCC or HTCC processes, 3) surface-mounted packages on printed circuits boards, and 4) 3D architectures. For the interconnections domain, it is now more important to be compatible with the level of integration required for the microwave modules: fuzz buttons, flex, sub-miniature connectors. AH of these technologies mastered by Thales are dual use for Airborne and Space, Military and Civilian applications. [J538]

"Reducing Impact of Pulsed Power Loads on Microgrid Power Systems"

Microgrid power systems are becoming increasingly common in a host of applications. In this work, the mitigation of the adverse affects of pulsed-power loads on these systems is considered. In microgrid power systems, pulsed loads are particularly problematic since the total system inertia is finite. Examples include ships and aircraft with high-power radars, pulsed weapons, and electromagnetic launch and recovery systems. In these systems, energy is collected from the system over a finite time period, locally stored, and then rapidly utilized. Herein, a new strategy to accommodate these loads is presented. This strategy is based on identifying the optimal charging profile. Using simulation and experiment, it is shown the proposed strategy is highly effective in reducing the adverse impact of pulsed-power loads. [J539]

"Radar Open System Architecture provides net centricity"

The second generation of the Radar Open Systems Architecture has been developed and put into practice. This approach consists of a layered architecture that isolates applications from underlying hardware and software elements such as operating systems, middlewares, communication fabrics, and computer platforms. The framework also consists of a set of component libraries that are being populated as the framework is applied in an expanding series of application domains. Easy swap ability for the library components or newly-developed components along with a high degree of hardware independence allows systems built using this infrastructure to be easily maintained and upgraded. [J540]

"Warren D. White award for excellence in radar engineering"

{no data available} [J541]

"Estimation of wall parameters by exploiting correlation of echoes in time domain"

Compensation of the effects of wall on through-the-wall synthetic aperture radar (SAR) imaging is a main concern. Wall parameters are essential for the compensation, which are normally not known a priori. After analysis of echo configuration characteristics in time domain, a new procedure for estimating wall parameters is proposed, which is based on the idea of exploiting the correlation between the measured returns reflected from the wall and the corresponding estimates calculated from a SAR return model of the wall together with electromagnetic theory. The new approach deals with echo data without imaging or localisation processing, and has a less resolution requirement. [J542]

"Low angle estimation in MIMO radar"

A low angle estimation method in the presence of the multipath for multiple-input multiple-output (MIMO) radar is proposed. The multipath signal model for MIMO radar is constructed with both transmitted multipath and received multipath signals being considered. To reduce the computational burden and retain estimation precision,

the beam-space maximum likelihood algorithm is developed for angle estimation. This method overcomes multipath effects for low angle measurement, and only requires one one-dimension search procedure. Simulation results are presented to verify the effectiveness of the proposed method. [J543]

"Dielectric-based leaky-wave antenna for high gain using a printed surface-wave source"

A multilayer leaky-wave antenna (LWA) is presented for microwave and millimetre-wave frequencies. By placing two superstrate dielectric layers on top of a base grounded dielectric slab, a practical resonant cavity structure can be realised for high gain at 17.39 GHz. The compact 6 Ч 6 cm LWA is fed by a printed surface-wave source integrated in the bottom ground plane. Measured gain values are greater than 11 dBi at broadside with half power beam less than 77°. The presented low cost and low profile LWA may be useful for radar applications and surveillance systems where lightweight and compact antenna designs are of interest. [J544]

"Doppler ambiguity resolution for multiple PRF radar using iterative adaptive approach"

A new improved complex-valued iterative adaptive approach is proposed to effectively resolve Doppler ambiguity in multiple pulse repetition frequency (PRF) radar. Exact termination criterion for the proposed method is adopted based on the sparsity of Doppler spectrum. Numerical studies demonstrated the effectiveness of the proposed method. [J545]

"The Early History of Radar [JHistorical]"

The history of radar has often been told by the nations who used it to win World War II (WWII). History books often stated that radar won the war for the Allies. This is probably an overstatement, as both sides used radar. Research on radar started in eight nations well before WWII: France, Germany, Italy, Japan, The Netherlands, the Soviet Union, the United Kingdom, and the United States. The first evidence of the radar principle sprung from wireless technology as early as 1897, when Alexander Popov observed interference caused by a passing ship while he was transmitting wireless signals. [J546]

"Direction of Departure (DOD) and Direction of Arrival (DOA) Estimation in MIMO Radar with Reduced-Dimension MUSIC"

This letter discusses the problem of direction of departure (DOD) and direction of arrival (DOA) estimation for multi-input multi-output (MIMO) radar, and derives a reduced-dimension multiple signal classification (MUSIC) algorithm therein. The proposed algorithm, which only requires one-dimension search, can avoid the high computational cost within two-dimension MUSIC (2D-MUSIC) algorithm. We illustrate that the algorithm has better performance ESPRIT algorithm, and has very close performance to 2D-MUSIC algorithm. Further our algorithm requires no pair matching. Simulation results verify the usefulness of our algorithm. [J547]

"The Kyoto & Carbon Initiative-A Brief Summary"

The Kyoto & Carbon (K&C) Initiative is an international collaboration led by the Japan Aerospace Exploration Agency (JAXA) that revolves primarily around the Advanced Land Observing Satellite (ALOS) Phased Arrayed L-band SAR (PALSAR). The Initiative builds on the experience gained from the Global Rain Forest Mapping (GRFM) and Global Boreal Forest Mapping (GBFM) projects [1], [2], in which SAR data from the Japanese Earth Resources Satellite (JERS-1) were used to generate consistent image mosaics over the entire tropical and boreal zones of Earth. While the GRFM and GBFM projects were undertaken already in the mid 1990s, they demonstrated the utility of L-band SAR data for mapping and monitoring forest and wetland areas and the importance of providing spatially and temporally consistent satellite acquisitions for regional-scale monitoring and surveillance. [J548]

"Aspect segmentation and feature selection of radar targets based on average probability of error"

Through statistical estimation by a non-parametric model, a fused polarimetric and resonant return from the radar target is modelled as a function of the target aspect angle. The outcome of this type of modelling is a set of non-parametric density estimates, which are then used to represent this target in a multi-dimensional probability space. These densities within this probability space can be well separated and therefore utilised to make decision rules to identify targets of interest. The return set to be modelled is the average power set associated with spectral bands centred on the target natural resonant frequencies. This return set is mapped into density set using a Gaussian kernel function; subsequently, the density set will be considered as the target radar feature set of interest. To decrease density overlapping between respective densities of different targets, a criterion based on the Bayesian error is employed; first, to bisect the aspect global range into smaller sectors, and second, to select discriminative features that can minimise the average probability of error between the

targets respective features. The results show that two targets with similar resonant frequencies can be separated by the Bayesian error criterion based on the proposed features. A simple likelihood ratio test had more than 80% success down to 20%dB of signal-to-noise ratio. [J549]

"Passive Time Reversal Acoustic Communications Through Shallow-Water Internal Waves"

During a 12-h period in the 2006 Shallow Water Experiment (SW06), binary phase shift keying (BPSK) signals at the carrier frequencies of 813 and 1627 Hz were propagated over a 19.8-km source-receiver range when a packet of strong internal waves passed through the acoustic track. The communication data are analyzed by time reversal processing followed by a single-channel decision feedback equalizer. Two types of internal wave effects are investigated in the context of acoustic communications. One is the rapid channel fluctuation within 90-s data packets. It can be characterized as decreased channel coherence, which was the result of fast sound-speed perturbations during the internal wave passage. We show its effect on the time reversal receiver performance and apply channel tracking in the receiver to counteract such fluctuation. The other one is the long-term (in the scale of hours) performance degradation in the depressed waveguide when the internal waves passed through the acoustic track. Even with channel tracking, the time reversal receiver experiences average 3-4-dB decrease in the output signal-to-noise ratio (SNR). Such long-term performance degradation is explained by the ray approximation in the depressed waveguide. [J550]

"Large-Area Classification and Mapping of Forest and Land Cover in the Brazilian Amazon: A Comparative Analysis of ALOS/PALSAR and Landsat Data Sources"

Information on the distribution of tropical forests is critical to decision-making on a host of globally significant issues ranging from climate stabilization and biodiversity conservation to poverty reduction and human health. The majority of tropical nations need high-resolution, satellite-based maps of their forests as the international community now works to craft an incentive-based mechanism to compensate tropical nations for maintaining their forests intact. The effectiveness of such a mechanism will depend in large part on the capacity of current and near-future Earth observation satellites to provide information that meets the requirements of international monitoring protocols now being discussed. Here we assess the ability of a state-of-the-art satellite radar sensor, the ALOS/PALSAR, to support large-area land cover classification as well as high-resolution baseline mapping of tropical forest cover. Through a comprehensive comparative analysis involving twenty separate PALSAR- and Landsat-based classifications, we confirm the potential of PALSAR as an accurate (>90%) source for spatially explicit estimates of forest cover based on data and analyses from a large and diverse region encompassing the Xingu River headwaters in southeastern Amazonia. Pair-wise spatial comparisons among maps derived from PALSAR, Landsat, and PRODES, the Brazilian Amazon deforestation monitoring program, revealed a high degree of spatial similarity. Given that a long-term data record consisting of current and future spaceborne radar sensors is now expected, our results point to the important role that spaceborne imaging radar can play in complementing optical remote sensing to enable the design of robust forest monitoring systems. [J551]

"Correction to "A New Vector Waveform Inversion Algorithm for Simultaneous Updating of Conductivity and Permittivity Parameters From Combination Crosshole/Borehole-to-Surface GPR Data""

In the above titled paper (ibid., vol. 48, no. 9, pp. 3391-3407, Sep. 10), there is an error in equation (A-5). The correct form is presented here. [J552]

"Application of compressive sensing to sparse channel estimation"

Compressive sensing is a topic that has recently gained much attention in the applied mathematics and signal processing communities. It has been applied in various areas, such as imaging, radar, speech recognition, and data acquisition. In communications, compressive sensing is largely accepted for sparse channel estimation and its variants. In this article we highlight the fundamental concepts of compressive sensing and give an overview of its application to pilot aided channel estimation. We point out that a popular assumption-that multipath channels are sparse in their equivalent baseband representation-has pitfalls. There are over-complete dictionaries that lead to much sparser channel representations and better estimation performance. As a concrete example, we detail the application of compressive sensing to multicarrier underwater acoustic communications, where the channel features sparse arrivals, each characterized by its distinct delay and Doppler scale factor. To work with practical systems, several modifications need to be made to the compressive sensing framework as the channel estimation error varies with how detailed the channel is modeled, and how data and pilot symbols are mixed in the signal design. [J553]

"Using ALOS/PALSAR and RADARSAT-2 to Map Land Cover and Seasonal Inundation in the

Brazilian Pantanal"

The Brazilian Pantanal is a large continuous tropical wetland with large biodiversity and many threatened habitats. The interplay between the distribution of vegetation, the hydrology, the climate and the geomorphology nourishes and sustains the large diversity of flora and fauna in this wetland, but it is poorly understood at the scale of the entire Pantanal. This study uses multi-temporal L-band ALOS/PALSAR and C-band RADARSAT-2 data to map ecosystems and create spatial-temporal maps of flood dynamics in the Brazilian Pantanal. First, an understanding of the backscattering characteristics of floodable and non-floodable habitats was developed. Second, a Level 1 object-based image analysis (OBIA) classification defining Forest, Savanna, Grasslands/Agriculture, Aquatic Vegetation and Open Water cover types was achieved with accuracy results of 81%. A Level 2 classification separating Flooded from Non-Flooded regions for five temporal periods over one year was also accomplished, showing the interannual variability among sub-regions in the Pantanal. Cross-sensor, multi-temporal SAR data was found to be useful in mapping both land cover and flood patterns in wetland areas. The generated maps will be a valuable asset for defining habitats required to conserve the Pantanal biodiversity and to mitigate the impacts of human development in the region. [J554]

"A CPW-Fed Printed Loop Antenna for Ultra-Wideband Applications, and its Linear-Array Performance"

A small CPW-fed loop antenna is described. The single antenna has a measured relative impedance bandwidth of 70%. Radiation patterns show stable co-polar and low cross-polar characteristics within the specified bandwidth. The small size of the radiator (0.5λ at 13.6 GHz) makes it suitable for being used in linear-array applications. The linear-array performance of the antenna is investigated by means of simulations and measurements. The mutual coupling in the array environment is reduced by means of slots placed on the antenna's surface. The impedance bandwidth is almost preserved after the antennas are embedded in an array environment. The radiation patterns of the array is also investigated by means of simulations and measurements. [J555]

"Rain-Cell Identification and Modeling for Propagation Studies from Weather Radar Images"

This study aims to characterize and model the rain fields for propagation studies from weather radar images of the northwest coast of Spain. The study includes the modeling of these images according to two well-known rain-cell models, EXCELL and HYCELL. For this analysis, a procedure for detecting rain field-s and an algorithm for identifying rain cells within the images is presented. This work is part of an ongoing activity, trying to develop dynamic space-time models of rain fields for simulating rain-induced effects on millimeter-wave communication systems. [J556]

"Report on MSMW'2010 and TERATECH'2010"

The International Kharkov Symposium on Physics and Engineering of Microwaves, Millimeter, and Sub-Millimeter Waves (MSMW) is now a well-known event, which is conducted regularly once every three years. This Symposium has a long history. In fact, the MSMW Symposium grew from a series of conferences on millimeter and sub-millimeter waves that were held from time to time in the USSR since 1974 in the Russian language. These conferences played an important role for research and development in these wavelength ranges. At that time, they were the only widely available forum that was attended by the leading scientists and engineers of the involved organizations from all over the USSR. It must be admitted that then, mm-wave research and development was considered a sensitive defense-related area, and the conferences were usually supervised by defense or double-purpose ministries of the USSR. A number of mm-wave radar, propagation, and communication projects were performed for the military. Sub-mm research and development was in fact concentrated around development of multi-channel interferometers-polarimeters, particularly for hot-plasma diagnostics in Tokomak nuclearfusion machines. [J557]

"Conjugate esprit algorithm for bistatic mimo radar"

A novel conjugate ESPRIT (C-ESPRIT) algorithm is proposed to estimate the direction of arrival (DOA) and direction of departure (DOD) for bistatic MIMO radar. It employs the properties of noncircular signals to construct a new virtual array first, the virtual antenna number of which is twice that of the MIMO virtual array. It then exploits the rotational invariance property of the new virtual array to estimate DOAs and DODs of multiple targets through ESPRIT which are paired automatically in a new way. This algorithm can provide more precise angle estimation and can detect more targets than well-known classical subspace methods. Simulation results validate these conclusions. [J558]

"Radar Backscatter from Conducting Polyhedral Spheres"

Electromagnetic backscatter characteristics of conducting polyhedral spheres, constructed of 12 pentagons and a large number of hexagons, were investigated. The polyhedral structures were classified by their number of vertices and by the width of the conducting edges in their frames. Polyhedral spheres with 60, 80, 180, 240, 320, 500, 540, 960, and 1500 vertices were evaluated for their ability to scatter electromagnetic waves back to a source. The edge widths were varied between the limits of (1) nearly zero, to produce a wire-frame sphere; and (2) full surface closure of the polygon holes in the sphere, to form solid conducting structures. Using Method-of-Moments simulations with the WIPL-D code, the monostatic scattering properties of these spheres were studied over a wide range of structural and frequency parameters. The spherical wire frames had up to a 10 dB larger radar cross section than the completely solid spheres. This result provides models for new light-weight radar cross section targets used as satellite-calibration spheres with enhanced radar cross section for easier detection, low mass for easier launch, and low drag cross section for long orbit life. With selected edge widths, the monostatic radar cross section becomes vanishingly small at specific anti-backscatter frequencies, for conducting spherical shells with a regular pattern of polygon holes. These shells can be placed around solid spheres to nearly eliminate radar reflection from the composite object at specific frequencies. The polyhedral conducting-mesh (PCM) spheres with vanishing radar cross section at a desired frequency have applications for isotropic scattering sources that reflect no energy back to the electromagnetic source. the anti-backscatter polyhedral conducting-mesh spheres may provide insight for future stealth applications with spherical targets. [J559]

"Experimental Rotary Transformers For Antenna Power Supplies and Control [JAntenna Designer's Notebook]"

Rotary transformers can be effectively used for low-noise amplifier (LNA) or down-converter power supply and control signal transmission in scanning-antenna applications. Three air-core designs, utilizing a square wave at audio frequencies, using HCMOS logic and giving a 5 V/0.6 A dc power feed, are discussed. The constructions allow further installation of RF rotary joints or other coaxial hardware up to a diameter of 100 mm. They add about 30 to 80 mm to the overall height of the antenna, depending on application and requirements. Bearing replacement with such a transformer is also possible, if adequate tolerances are met and suitable coil-support materials are selected. [J560]

"Photonic Probes and Advanced (Also Phaseless) Near-Field Far-Field Techniques"

We present innovative near-field test ranges, named compact-near-field (CNF) and very-near-field (VNF). These use photonic probes, and advanced near-field far-field (NFFF) transformations from amplitude and phase (complex) or phaseless measurements. The photonic probe allows AUT-probe distances of less than one wavelength. This drastically reduces test-range and scanner dimensions, improves the signal-to-clutter ratio and the signal-to-noise ratio, and reduces the scanning area and time. In both the cases of complex and phaseless measurements, the neat-field-to-far-field transformation problem is properly formulated to further improve the rejection of clutter, noise, and truncation error. The advantages of the compact-near-field and very-near-field test ranges are discussed and numerically analyzed. Experimental results are presented for both planar and cylindrical scanning geometries. [J561]

"Terahertz Antenna System for a Near-Video-Rate Radar Imager [JAntenna Applications]"

In this contribution. we present simulations and measurements of a reflector system that can rapidly scan a terahertz beam for a high-resolution standoff-imaging application, without compromising the beam quality. The antenna system utilizes a Gregorian confocal-reflector geometry, with a small mechanical rotating mirror. The system has been successfully fabricated and tested, with THz imagery of targets at a 25 m standoff range being obtained In five seconds. for the current configuration. We also describe how frame rates exceeding 2 Hz can be achieved using a heterodyne array of just a few elements, with or without a multiplexing technique. [J562]

"Impact of low intensity millimetre waves on cell functions"

Investigations on the biological impact of low levels of millimetre-wave energy date back to the first experiments on the generation and detection of these high-frequency signals by Sir Jagadis Chunder Bose at the end of the 19th century. Slightly more than a hundred years later, millimetre-wave transmission has become a ubiquitous commercial reality. Despite the widespread use of millimetre-wave transmitters for communications, radar and even non-lethal weapons systems, only a handful of researchers have funded programmes focusing on millimetre-wave interactions with biological systems. As such, there is a growing need for a better understanding of the mechanisms of these interactions and their possible adverse and therapeutic implications. Independent of the health impact of long-term exposure to high doses of millimetre-wave energy on whole organisms, there

exists the potential for subtle effects on specific tissues or organs which can best be quantified in studies which examine real-time changes in cellular function as energy is applied. In this Letter, a series of experiments are presented which show changes in cell membrane potential and the action potential firing rate of cortical neurons under short (1 min) exposures to continuous-wave 60 GHz radiation at W/cm2power levels, more than 1000 times below the US government maximum permissible exposure. The findings have implications for non-contact stimulation and control of neurologic function, and might prove useful in a variety of health applications from suppression of peripheral neuropathic pain to the treatment of central neurological disorders. [J563]

"Solicitation for Measurements Corner [JMeasurements Corner]"

We welcome contributions for future installments of the Measurements Comer. Please send them to Brian Fischer and Ivan LaHaie, and they will be considered for publication as quickly as possible. Contributions can range from short notes to fun-length papers on all topics related to RF measurement technology and its applications, including antennas, propagation, materials, scattering, and radar cross section. New or unique measurement techniques are of particular interest. [J564]

"Electropollution or Sustainable Energy? [JAP-S Turnstile]"

Electropollution n. Nonionizing electromagnetic radiation propagated through the atmosphere by broadcast towers, radar installations, and microwave appliances, and the magnetic fields surrounding electrical appliances and power lines, which is believed to have polluting effects on people and the environment; also called electromagnetic smog. [J565]

"Warren D. White award for excellence in radar engineering"

{no data available} [J566]

"Cognitive-Radio Systems for Spectrum, Location, and Environmental Awareness"

In order to perform reliable communications, a system needs to have sufficient information about its operational environment, such as spectral resources and propagation characteristics. Cognitive-radio technology has capabilities for acquiring accurate spectrum, location, and environmental information, due to its unique features such as spectrum, location, and environmental awareness. The goal of this paper is to give a comprehensive review of the implementation of these concepts. In addition, the dynamic nature of cognitive-radio systems-including dynamic spectrum utilization, transmission, the propagation channel, and reception-is discussed, along with performance limits, challenges, mitigation techniques, and open issues. The capabilities of cognitive-radio systems for accurate characterization of operational environments are emphasized. These are crucial for efficient communications, localization, and radar systems. [J567]

"Indoor 3D Full Polarimetric Bistatic Spherical Facility for Electromagnetic Tests"

A new indoor facility for electromagnetic measurements has been developed and built at the Detectability and Electronic Warfare Laboratory, INTA, Spain. The system was designed to extend the previous capabilities so that not only monostatic but also bistatic radar cross section (RCS) tests could be easily conducted. Due to limited space, far-field radar cross sections in the system are restricted to small targets, but this layout will allow the researchers to investigate ReS near-field-to-far-field transformations. The system was also conceived to be versatile enough to carry out other tests, such as near-field antenna measurements, material-absorption measurements, and electromagnetic characterization of materials. The paper describes the novel concept behind the facility, and presents some preliminary measurement results on different applications. [J568]

"Warren D. White award for excellence in radar engineering"

{no data available} [J569]

"A Wireless Soil Moisture Smart Sensor Web Using Physics-Based Optimal Control: Concept and Initial Demonstrations"

This paper introduces a new concept for a smart wireless sensor web technology for optimal measurements of surface-to-depth profiles of soil moisture using in-situ sensors. The objective of the technology, supported by the NASA Earth Science Technology Office Advanced Information Systems Technology program, is to enable a guided and adaptive sampling strategy for the in-situ sensor network to meet the measurement validation objectives of spaceborne soil moisture sensors. A potential application for this technology is the validation of products from the Soil Moisture Active/Passive (SMAP) mission. Spatially, the total variability in soil-moisture

fields comes from variability in processes on various scales. Temporally, variability is caused by external forcings, landscape heterogeneity, and antecedent conditions. Installing a dense in-situ network to sample the field continuously in time for all ranges of variability is impractical. However, a sparser but smarter network with an optimized measurement schedule can provide the validation estimates by operating in a guided fashion with guidance from its own sparse measurements. The feedback and control take place in the context of a dynamic physics-based hydrologic and sensor modeling system. The overall design of the smart sensor web-including the control architecture, physics-based hydrologic and sensor models, and actuation and communication hardware-is presented in this paper. We also present results illustrating sensor scheduling and estimation strategies as well as initial numerical and field demonstrations of the sensor web concept. It is shown that the coordinated operation of sensors through the control policy results in substantial savings in resource usage. [J570]

"Biomimetic electrically small antennas"

Many insects possess acute directional hearing capabilities and are able to localise a sound source of interest with a good degree of precision. An analogy can be drawn between the hearing mechanisms of such insects and a two-element, electrically small antenna array. Presented is a biomimetic electrically small antenna array that mimics the hearing mechanism of an insect with hyperacute directional hearing capability. A prototype of such an antenna has been fabricated and its simulated and measured results are presented. Such biomimetic antenna arrays could be used in numerous applications ranging from miniaturised RF sensors and direction finding systems to small aperture, high-resolution microwave imaging systems and radars. [J571]

"Multichannel SAR With Reflector Antenna for High-Resolution Wide-Swath Imaging"

To overcome the inherent limitation between high azimuth resolution and wide swath in the conventional one-channel synthetic aperture radar (SAR) system, a large receiving planner antenna, which is split into multiple subapertures in both azimuth and elevation, is usually adopted. However, such a system has high system implementation complexity and requires azimuth signal reconstruction under nonuniform sampling condition. To reduce the complexity of the SAR system and processing algorithm, a reflector antenna is adopted in the spaceborne multichannel SAR system presented in this letter for high-resolution wide-swath (HRWS) imaging. According to the special characteristics of reflector antenna, a modified single-phase-center (SPC) technique is presented. The system configuration and imaging scheme are described in detail. A typical spaceborne SAR example with a reflector antenna for HRWS imaging is designed, and its performances are analyzed. Simulation results denote that the presented SAR system shows satisfactory performances with lower data rate, system load, and implementation complexity. [J572]

"An Evaluation of the ALOS PALSAR L-Band Backscatter-Above Ground Biomass Relationship Queensland, Australia: Impacts of Surface Moisture Condition and Vegetation Structure"

Focusing on woody vegetation in Queensland, Australia, the study aimed to establish whether the relationship between Advanced Land Observing Satellite (ALOS) Phased Array L-band SAR (PALSAR) HH and HV backscattering coefficients and above ground biomass (AGB) was consistent within and between structural formations (forests, woodlands and open woodlands, including scrub). Across these formations, 2781 plot-based measurements (from 1139 sites) of tree diameters by species were collated, from which AGB was estimated using generic allometric equations. For Queensland, PALSAR fine beam dual (FBD) 50 m strip data for 2007 were provided through the Japanese Space Exploration Agency's (JAXA) Kyoto and Carbon (K&C) Initiative, with up to 3 acquisitions available for each Reference System for Planning (RSP) paths. When individual strips acquired over Queensland were combined, `banding' was evident within the resulting mosaics, with this attributed to enhanced L-band backscatter following rainfall events in some areas. Reference to Advanced Microwave Scanning Radiometer-EOS (AMSR-E) data indicated that strips with enhanced L-band backscatter corresponded to areas with increased effective vegetation water content (kg m-2) and, to a lesser extent, soil moisture (g cm-3). Regardless of moisture conditions, L-band HV topographically normalized backscattering intensities backscatter (σfo) increased asymptotically with AGB, with the saturation level being greatest for forests and least for open woodlands. However, under conditions of relative maximum surface moisture, L-band HV and HH σfowas enhanced by as much as 2.5 and 4.0 dB respectively, particularly for forests of lower AGB, with this resulting in an overall reduction in dynamic range. The saturation level also reduced at L-band HH for forests and woodlands but remained similar for open woodlands. Differences in the rate of increase in bo--th L-band HH and HV σfowith AGB were observed between forests and the woodland categories (for both relatively wet and dry conditions) with these attributed, in part, to differences in the size class distribution and stem density between non-remnant (secondary) forests and remnant woodlands of lower AGB. The study concludes that PALSAR data acquired when surface moisture and rainfall are minimal allow better estimation of the AGB of woody vegetation and that retrieval algorithms ideally need to consider differences in surface moisture conditions

and vegetation structure. [J573]

"RCS Measurement Setup for Periodic-Structure Prototype Characterization"

A radar cross section (RCS) measurement setup for the characterization and measurement of periodic structures is presented. The idea is to modify an existing spherical range in an anechoic-chamber setup, allowing scattered-field measurements of PEC and artificial magnetic conductor prototypes. With the proposed setup, the scattered field of the object under test (OUT) can be measured for different azimuth and roll angles, as well as for any incident wave polarization. The measurement setup's performance is validated by comparing simulations and measurements. Finally, a combined PEC-artificial magnetic conductor surface, intended for RCS reduction, was measured with the proposed setup. [J574]

"Nonlinear Calibration of Polarimetric Radar Cross Section Measurement Systems"

Polarimetric radar cross section measurement systems are characterized by polarimetric system parameters εhand εv. These parameters can be measured by use of rotating dihedrals. The full polarimetric dataset as a function of the angle of rotation can be analyzed with a nonlinear set of calibration equations to yield the system-parameter complex constants and the four polarimetric-calibration amplitudes. These amplitudes appropriately reproduce the system's drift, and very accurately satisfy a drift-free system-configuration criterion. The results indicate that the nonlinear approach is better than the previously studied linear approach, which yielded system parameters that were seriously distorted by system drift. [J575]

"Detection of handguns by their complex natural resonant frequencies"

The decomposition of the late time, transient response of metallic objects illuminated with broadband microwave energy into damped sinusoidal signals which are characterised by aspect-independent poles, is used extensively as a method of radar identification of aircraft and missiles. This method is utilised here for the detection and discrimination of handguns and non-threatening items, such as mobile phone handsets, cameras, keys and pens. It is of critical importance to explore the limits of this method, if it is to be utilised for the detection of such objects concealed on the human body or in bags carried on or close to the body that the limits of this technique is explored. Here, investigation is made by computer modelling of the complex natural resonances of two different handguns and these are compared with those for two non-threat items: a mobile phone handset and a fountain pen. Dependence of pole positions on small details present on a handgun is also investigated as is the effect of combining threat and non-threat items in close proximity. A way of enhancing the natural resonances by the use of a cross polarised receiver is also investigated. [J576]

"On the Operating Principles of UWB, CPW-Fed Printed Antennas"

The working principles of coplanar-waveguide (CPW) -fed, ultra-wideband (UWB) printed antennas are investigated. The behavior of the current distributions at different frequencies are examined. The modifications in the current distributions when the phase of the currents changes lead us to some conclusions on the behavior of UWB antennas. [J577]

"Electropollution or Sustainable Energy? [JMicrowave Surfing]"

The definition of electropollution (noun): Nonionizing electromagnetic radiation propagated through the atmosphere by broadcast towers, radar installations, and microwave appliances, and the magnetic fields surrounding electrical appliances and power lines, which is believed to have polluting effects on people and the environment; also called electromagnetic smog [1]. [J578]

"Warren D. White award for excellence in radar engineering"

{no data available} [J579]

"Photonic Beamformer Receiver With Multiple Beam Capabilities"

A multiple-beam photonic beamforming receiver is proposed and demonstrated. The architecture is based on a large port-count demultiplexer and fast tunable lasers to achieve a passive design, with independent beam steering for multiple beam operation. A single true time delay module with four independent beams is experimentally demonstrated, showing extremely smooth RF response in the -band, fast switching capabilities, and negligible crosstalk. [J580]

"The Six-Port in Modern Society"

Modern wireless sensing and communication systems are often based on high bandwidth and high carrier frequencies. In the range beyond 100 GHz, common receiver architectures, like active homodyne or heterodyne receivers, have an issue with the amplification needed for mixing. Also, high bandwidth is a problem for these systems. In this context, the six-port receiver is a good alternative, just as well as for lowvolume markets. The six-port concept is based on the additive superposition of the two RF input signals using four different relative phases leading to constructive or destructive interaction. The resulting signals are directly downconverted to baseband by diode circuits operated in detector or mixing mode. The complexvalued information can be easily reconstructed from the four baseband voltages. Historic evolution leads from the reflectometer approach for an alternative vector network analyzer to receivers for sensing and communications. A recent topic is the technology gap in automotive workshops for adjusting the long-range radar sensor of a car. Here, the six-port concept as alignment tool is a good choice, because of its excellent phase resolution. Currently, the integration of the six-port receiver on a MMIC for frequencies beyond 100 GHz is the focus of current work and will be intensified in the future. Will the six-port concept replace common active homodyne and heterodyne receivers? No, but it is a serious alternative for millimeter-wave frequencies and ultrahigh-bandwidth applications in wireless sensing and communication systems. This modern concept can tap new markets for both wireless sensors and sensor networks. [J581]

"Countering stealth with passive, multi-static, low frequency radars"

The potential of passive, multi-static radars as covert sensors for the detection of low flying, stealth air targets are illustrated by multi-static RCS analysis, coverage simulations for low flight levels and measurement results obtained with an experimental passive radar using digital audio broadcast signals (DAB). The measurement sensor is described and future perspectives are pointed out. [J582]

"Measurements of the effects of multipath interference on timing accuracy in a cellular radio positioning system"

The authors present a quasi-interferometric technique for measuring the flight times of signals broadcast by global system for mobile communication (GSM) transmitters, together with measurements made using the technique in and around Cambridge, UK. The data are used to determine the errors associated with GSM signal arrival times in various environments. The majority of the timing errors in all signal environments lie in the range -1 to +1.5 μs, with the tails of the distributions extending beyond +3 μs. The authors show that these large timing errors are caused by the distortions of the cross-correlation peaks used to determine the signal arrival times as a result of coherent multipath interference. Models of timing errors, based on Cauchian distributions, fit the experimental data better than those based on symmetrical or skewed Gaussian functions. This has implications for attempts to combine GSM and global navigation satellite system measurements using Kalman filters. [J583]

"Detection Algorithms to Discriminate Between Radar Targets and ECM Signals"

We address adaptive detection of coherent signals backscattered by possible point-like targets or originated from electronic countermeasure (ECM) systems in presence of thermal noise, clutter, and possible noise-like interferers. In order to come up with a class of decision schemes capable of discriminating between targets and ECM signals, we resort to generalized likelihood ratio test (GLRT) implementations of a generalized Neyman-Pearson rule (i.e., for multiple hypotheses). The adaptive detectors rely on secondary data, free of signal components, but sharing the statistical characterization of the noise in the cell under test. The performance assessment focuses on an adaptive beamformer orthogonal rejection test (ABORT)-like detector; analytical expressions for the probability of false alarm, the probability of detection of the target, and the probability of blanking the ECM (coherent) signal are given. More remarkably, it guarantees the constant false alarm rate (CFAR) property. The performance assessment shows that it can outperform the adaptive sidelobe blanker (ASB) in presence of ECM systems. [J584]

"Direct-path suppression by spatial filtering in digital television terrestrial broadcasting-based passive radar"

The signal model of digital television terrestrial broadcasting (DTTB) is introduced and its ambiguity function is analysed here. In order to suppress the direct-path (and multipath) interference generated by single frequency network in DTTB-based passive radar, the corresponding spatial filtering methods are designed according to the feature of each channel. In the echo channel, the interference is suppressed by discarding the signal-subspace. The noise-subspace can be estimated from the power of the covariance matrix to avoid the eigen-decomposition and to eliminate the need to obtain the corresponding dimension. In the reference channel, the transmitting signal of a certain transmitter is regarded as the desired signal. The desired signal will be cancelled by

conventional spatial filtering algorithms for the high signal-to-noise ratio case, which will also result in a distorted pattern and high side-lobes. To solve this problem, an improved general side-lobe canceller structure is proposed to realise the adaptive beamformer. To improve the robustness of the proposed methods and suppress the distributed clutter, the `broad null` algorithm is combined with the beamformer. The simulation results show that the proposed methods are effective to suppress the interference in DTTB-based passive radar. [J585]

"Time-frequency imaging algorithm for highspeed spinning targets in two dimensions"

This study focuses on the narrow-band radar imaging for high-speed spinning targets. Based on the time-frequency characteristic of the echoed signal, a novel coherent spectrogram redistribution method, coherent single range Doppler interferometry (CSRDI), is proposed, which is capable of generating high-resolution imagery by applying a phase matched processing. Furthermore, the approach performs well at low signal-to-noise ratio. The spinning rate error is also taken into consideration and an estimation approach based on the focal entropy is proposed. The validity is confirmed by real data and numerical simulations. [J586]

"Indirect Localization and Imaging of Objects in an UWB Sensor Network"

A method for the localization and the rough 2-D microwave imaging of objects is described. It detects and utilizes line-of-sight (LOS) paths between a mobile node and several fixed nodes of a distributed ultrawideband (UWB) sensor network. Objects are imaged in an indirect way, i.e., by a combination of maps, which show the distribution of LOS paths of individual network nodes. The method is demonstrated by means of ray-tracing simulations and measurements in a realistic environment. Performance limitation by diffraction and the question of temporal network node synchronization are discussed. [J587]

"Airships Ahoy"

Residents of Caribo, Maine, who happened to glance up at the skies over the former Loring Air Force Base recently got a glimpse of the future-although they might have thought they were looking at something out of the past. Engineers from my company, Science Applications International Corp. (SAIC), in McLean, Va., have been conducting test flights of a new type of lighter-than-air vehicle. [J588]

"nth-order multi-bit ΣΔ ADC using SAR quantiser"

An nth-order multi-bit delta-sigma (ΣΔ) analogue-to-digital converter (ADC) using a successive approximation register (SAR) quantiser is proposed. By exploiting the residue voltage of a multi-bit SAR ADC, the proposed ADC performs as an nth-order noise shaping converter with only one opamp and removes the need for a feedback multi-bit DAC. In addition, the proposed architecture is very reconfigurable and can be implemented as a bandpass ADC. [J589]

"Coherent Detection of Swerling 0 Targets in Sea-Ice Weibull-Distributed Clutter Using Neural Networks"

The detection of Swerling 0 targets in movement in sea-ice Weibull-distributed clutter by neural networks (NNs) is presented in this paper. Synthetic data generated for typical sea-ice Weibull parameters reported in the literature are used. Due to the capability of NNs for learning the statistical properties of the clutter and target signals during a supervised training, high clutter reduction rates are achieved, reverting on high detection performances. The proposed NN-based detector is compared with a reference detector proposed in the literature that approximates the Neyman-Pearson (NP) detector. The results presented in the paper allow empirically demonstrating how the NN-based detector outperforms the detector taken as reference in all the cases under study. It is achieved not only in performance but also in robustness with respect to changes in sea-ice Weibull-distributed clutter conditions. Moreover, the computational cost of the NN-based detector is very low, involving high signal processing speed. [J590]

"Fast Realization of Maximum Likelihood Angle Estimation With Small Adaptive Uniform Linear Array"

A maximum likelihood (ML) angle estimator can obtain optimal angle estimation performance. A fast implementation of ML angle estimation is developed with small adaptive uniform linear arrays (ULA). The presented method obtains the extreme points of the ML function employing real polynomial rooting, and then determines the ML solution by searching for the maximum among the local maximum values of the ML function. It can obtain the global optimal solution of the ML estimator with low computational complexity. [J591]

"CMOS SPDT T/R switch for X-band, on-chip radar applications"

An SPDT transmit/receive (T/R) switch for X-band on-chip radar applications is proposed with the combination of new techniques. These methodologies include optimisation of the transistor widths for lower insertion loss (IL) while preserving high isolation and using a parallel resonance technique to improve isolation. Also, techniques such as applying DC bias to source and drain, using on-chip impedance transformation networks (ITN) and body-floating are used to improve power handling capability (P1dB) of the switch. All these techniques result in the switch with insertion loss less than 1.3 dB, isolation between transmit and receive ports better than 29.2 dB, 29 dBm input P1dBand return loss of better than 22 dB from 8 to 12 GHz in 0.44 mm2chip area. [J592]

"Compensation of Range Migration for Cyclically Repetitive Doppler-Sensitive Waveform (OFDM)"

Range migration, which occurs for targets with high velocity when the radar range resolution is high, is solved by exploiting the cyclically repetitive waveform-namely, orthogonal frequency division multiplexing. The proposed technique is based on a signal processing method that solves the Doppler ambiguity by exploiting the Doppler sensitivity of the multicarrier spread spectrum structure. The new method extends the availability of narrowband delay-Doppler processing to a wider range of waveform and target parameters. [J593]

"Ortho-Rectification and Slope Correction of SAR Data Using DEM and Its Accuracy Evaluation"

This paper proposes an accurate ortho-rectification and slope correction method for Synthetic Aperture Radar (SAR) images using a digital elevation model (DEM). Since SAR observation is performed in the squint condition, the image is distorted both geometrically and radiometrically (e.g., through foreshortening, range and azimuth shift, layover, radiometric modulation associated with slope, and shadowing). Furthermore, the pixel height cannot be retrieved directly even when orbital data are accurate. The proposed method calculates the geometric and radiometric distortion components from a comparative process between the DEM-based Simulated SAR Image (DSSI) and the SAR slant range image. When applied to Advanced Land Observing Satellite (ALOS) Phased Array Type L-band SAR (PALSAR) data, the geometric accuracy of the ortho-rectified SAR image at the off-nadir angle of 34.3° was high, with a Root Mean Square Error (RMSE) of 11.9 m when evaluated against Ground Control Points (GCPs) deployed globally. The slope correction effectively reduced the radiometric variation caused by the terrain height variation. The proposed method can be applied to a range of SAR data to support a diversity of applications. [J594]

"Multi-Channel SAR-GMTI Method Robust to Coregistration Error of SAR Images"

High accuracy in complex images coregistration is essential in ground moving target indication (GMTI) processing of synthetic aperture radar (SAR) data, normally termed SAR-GMTI. The clutter suppression performance is proportional to the coregistration accuracy. In this correspondence, we propose a new SAR-GMTI approach, which is robust to the SAR images coregistration error. The observed clutter-plus-noise vector is built using the neighboring pixels as the first step, thus the corresponding covariance matrix, termed as joint covariance matrix, can be estimated. The joint noise subspace is obtained by eigen-decomposing of the joint covariance matrix. The clutter is suppressed successfully by a projecting operation, i.e., a projection of the joint observed vector into the resulting joint noise subspace. The information of neighboring pixels is substantially exploited in the clutter suppression, resulting in the robustness, even at the presence of large coregistration error. Both the simulated and real multi-channel airborne data are used to validate the proposed approach. [J595]

"Scaled Radon-Wigner Transform Imaging and Scaling of Maneuvering Target"

The use of scaled Radon-Wigner transform (RWT) imaging and simultaneous cross-range scaling is proposed for a maneuvering target using a signal model of a rotating target with uniform acceleration. Three steps are needed to realize such a process. First, the rotational parameters are calculated via the weighted linear least squares method after obtaining frequency modulation parameters of signals in multirange cells. Second, rotational parameters are used to compensate for the slow-time signals. Third, inverse synthetic aperture radar imaging of scaled RWT is implemented with cross-range scaling. Parameter substitution changes every component signal from a slanting line to a horizontal line in the time-frequency plane, and the horizontal line integral can be expressed as a cross-range profile. Compared with conventional RWT imaging methods, this algorithm improves calculation speed greatly and provides more stable imaging performance. This method was tested successfully with simulated and experimental radar data. [J596]

"Multipactor Effect Analysis and Design Rules for Wedge-Shaped Hollow Waveguides"

A numerical model for predicting the multipactor breakdown effect in wedge-shaped hollow waveguides is

presented in this paper. The computation of electromagnetic fields is based on the boundary integral-resonant mode expansion method, which provides the modal chart of hollow waveguides with any arbitrary cross section. The advantage of using wedge-shaped waveguides with respect to conventional rectangular ones is the deviation of the resonant paths of the electrons toward regions with lower voltages, thus reducing the probability of multipactor threshold for certain input power. To validate this method, our results have been compared with simulations from previous theoretical studies. Once the simulation tool is validated, it is used to predict the multipactor threshold of wedge-shaped waveguides with different symmetric inclination angles of their horizontal plates. Finally, susceptibility curves as the ones already available for rectangular waveguides are presented. These charts are useful for designing innovative waveguide geometries with improved multipactor-free working power ranges. [J597]

"Generating Large-Scale High-Quality SAR Mosaic Datasets: Application to PALSAR Data for Global Monitoring"

This paper proposes a mosaicking algorithm to produce large-scale radiometrically and geometrically calibrated Synthetic Aperture Radar (SAR) datasets as a base for environmental monitoring of terrestrial biospheric and cryospheric changes. Features of the proposed method are thematic inclusion of a) long-strip processing of the SAR data, b) ortho-rectification and slope correction using a digital elevation model, c) suppression of differences in intensity between neighboring strips, and d) preparation of metadata (e.g., dates from launch, local incidence angle, radar shadow, layover, and valid/invalid data) to support dataset interpretation. The performance of the proposed method is evaluated using Advanced Land Observing Satellite (ALOS) Phased Array type L-band SAR (PALSAR) mosaics for Southeast Asia, Australia, and Africa. [J598]

"An Experimental Study of WiMAX-Based Passive Radar"

Passive radars using illuminators of opportunity have attracted much attention in recent years. The worldwide inter-operability for microwave access (WiMAX) signal is a new illumination source for passive radar. This paper presents a study to understand and to demonstrate the feasibility of using WiMAX signals for passive radar. The study includes WiMAX signal analysis, the design and implementation of a WiMAX-based passive radar demonstrator, the associated radar signal processing scheme, and the field measurements. Results based on field measurements for various moving targets provide some useful references about the performance and potential capability of using WiMAX signals for passive radar applications. [J599]

"PALSAR Wide-Area Mapping of Borneo: Methodology and Map Validation"

This paper describes the operational radar mapping processing chain developed and steps taken to produce a provisional wide-area PALSAR forest and land cover map covering Borneo for the year 2007, compliant with emerging international standards (CEOS guidelines, FAO LCCS). A Bayesian approach based on (unsupervised) mixture modeling followed by Markov Random Field (MRF) classification has been selected for its suitability and flexibility to deal with a situation where ground truth is sparse and sometimes ambiguous. The methodology is based on the classification of Fine Beam Single (FBS) and Fine Beam Dual (FBD) polarization (path) image pairs. To cover Borneo the equivalent of 554 standard images is required. Qualitative and quantitative validation results and findings are reported. The final overall accuracy assessment result shows the demonstration map product is in 85.5% full agreement with the independent reference dataset and in 7.8% 'partial agreement'. The accuracy achieved is widely considered adequate, a very promising result for a sub-continental high resolution map based on just single-year radar data. Approaches for further improvement of the accuracy of less accurately classified thematic classes such as grassland, cropland and shrubland are suggested. This work has been undertaken in part within the framework of the ALOS Kyoto & Carbon Initiative. [J600]

"Bias-Free Phase Tracking with Linear and Nonlinear Systems"

The arctan function is a well-known Maximum Likelihood (ML) estimator of the phase angle $\alpha \in [-\pi,\pi)$ of a complex signal in additive white Gaussian noise. In this paper we revisit the arctan-based ML phase estimator and identify the bias problem for phase tracking. We show that the posteriori probability density function of α becomes a bi-modal distribution for small values of signal to noise ratio ρ and larger values of α. In such cases the mean and the mode differ from each other, and as a result when such ML phase estimates are used as an input to a linear system (LS), example for phase tracking, the resulting output (which is essentially the mean value of the phase) differs from its true value which is the mode. In such situations there exist a mean (tracking) error at the output of the LS from its true value α, and in (non-Bayesian) statistical terms there exist a bias in the estimates. In this paper, we provide some statistical analysis to explain the above problem, and also provide solutions for bias correction when a LS is used for tracking phase. Furthermore, we also provide two nonlinear phase tracking systems, 1) a Monte-Carlo based sequential phase tracking technique and 2) a second-order

digital-phase locked loop based method, for bias-free phase tracking which eliminate the bias problem that occurs in the case of linear phase tracking with ML estimates. [J601]

"Potential of passive-AIS technology"

Presented is a first exploratory investigation on the potential to use an automatic identification system (AIS) for multistatic passive coherent location applications. This concept can provide a low-cost maritime traffic monitoring capability to verify the AIS self-reported ship positions and to detect additional ships, still avoiding active emissions. [J602]

"Polarimetric SAR image fusion using nonnegative matrix factorisation and improved-RGB model"

Since different polarimetrie channels have different dynamical ranges, nonnegative matrix factorisation (NMF) is explored for fusing polarimetric SAR (PolSAR) data in a single colour image. The data of the three polarimetric channels (HH, HV and VV) with total power (TP) data is fully utilised to implement the NMF, and the choice of normalised factors for different polarimetric channels based on the same probability is applied, which produces an improved-RGB model. Combining the improved-RGB model with NMF, this approach brings in fusion images with higher spatial resolution and the power component preserved. [J603]

"Microwave PSK encoder based on shock excitation of magnetisation precession in YIG/GGG structure"

An original arbitrary phase shift keying microwave encoder based on DC magnetic pulse-tailored control of spin ringing in ferromagnetic thin films is presented. This physical principle leads to a simple implementation of a phase-coded chain of microwave oscillations applicable to wireless telecommunications and radar systems. [J604]

"Air target detection using airborne passive bistatic radar"

Passive bistatic radar (PBR) research has traditionally focused on using a static ground based receiver for air target detection. Reported are the initial findings from a novel airborne PBR experiment using commercial FM transmissions between 88 and 108 MHz, as illuminators of opportunity. A two-channel PBR system was designed, constructed and installed on a light aircraft and the system flown with the intention of detecting low altitude commercial air targets in the vicinity of London s Heathrow and Gatwick airports. Analysis of the data has shown that the system has successfully detected high velocity air targets on established air routes around the southeast of England. These encouraging results provide the proof of concept necessary to stimulate further development of the radar demonstrator to give improved target localisation and sensitivity. [J605]

"Eco-Hydrological Characterization of Inland Wetlands in Africa Using L-Band SAR"

Maps describing the eco-hydrology of inland wetland systems in Africa are needed to identify and implement appropriate adaptive management plans related to land use and land cover. Many African countries lack regional baseline information on the temporal extent, distribution and characteristics of wetlands. This information is provided here in the form of maps which characterize two wetland sites of international importance in Malawi and Mozambique. Multi-temporal L-band Synthetic Aperture Radar (SAR) datasets are combined with Landsat Thematic Mapper and ASTER images, digital elevation models, and vegetation species data to provide information on wetland ecology and hydrology. These data were used as input to a hybrid, Decision Tree classifier and a Principal Components Analysis classification approach to produce maps depicting the spatial distribution of vegetation species and characterizing the wetland dynamics. The maps exhibit classification accuracies of 89% and 84% for the two sites respectively. The L-band SAR datasets have proved to be an essential information source in the production of these maps due to (i) frequent cloud cover/smoke which reduces the temporal coverage of optical data, and (ii) a systematic observation strategy and frequent image acquisition which enables characterization of the flood dynamics at a high temporal resolution. [J606]

"One-Dimensional Frequency-Domain Features for Aircraft Recognition from Radar Range Profiles"

To extract effective one-dimensional frequency-domain features from high-resolution radar range profiles, the differential power spectrum (DPS) and the product spectrum, which were originally proposed for the speech signal processing, are introduced to the radar target recognition community. Through differentiating the power spectrum with respect to frequency, we obtained the DPS, which is translation invariant. The DPS can preserve the spectral information contained in the range profiles. The product spectrum is defined as the product of the power spectrum and the group delay function. Thus, it can combine the information contained in the magnitude spectrum and phase spectrum of the range profiles and then carry more details about the shape of the aircrafts.

In the classification phase, an optimal choice can be determined by implementing six different training algorithms of multilayered feed-forward neural network. The range profiles were measured by using the two-dimensional backscatters distribution data of four different scaled aircraft models. Simulations were demonstrated to evaluate the classification performance with the DPS and the product spectrum-based features. The simulation results have shown that both DPS and product spectrum-based features are effective for the automatic target recognition (ATR) of aircrafts. [J607]

"Micro-Doppler Signature Extraction from Ballistic Target with Micro-Motions"

Precession and nutation of the warhead and the wobble of decoys are the typical micro-motions of ballistic targets, and micro-Doppler analysis is a new way to investigate micro-motions. Based on the difference of micro-motions between the warhead and decoys, micro-Doppler signatures might be extracted for radar target identification, which is seen as a good method and a technique of great potential. We build micro-motion models of a ballistic missile target, including precession, nutation, and wobble; develop a novel model of micro-Doppler modulations based on the proposed concept of the micro-motion matrix; derive the formulas of micro-Doppler induced by the three micro-motions; and verify them by simulation studies. In order to further approach the actual case, the effective point scatterer model and the occlusion effect are considered in micro-Doppler, and the simulated results are shown compared with ones under the fixed point scatterer model and without the occlusion effect. In addition the precession experiment is performed in a microwave chamber, and the measured result is in accordance with the simulated result and the computed result. [J608]

"Estimation of the -Scattered Amplitude in Additive Noise"

We recall a recent diffusion model by Field & Tough [4], in which stochastic differential equations accounting for the continuous dynamics of the ^-scattering have been proposed together with an expression for the intensity autocorrelation function. The finite impulse response Wiener filter enables the design of the optimal filter to retrieve the scattered amplitude when the clutter is placed in superposition with thermal noise. Two possible applications are discussed: the estimation of the parameter B (the reciprocal of which is a characteristic time for the autocorrelation function) and the inference of the scattering cross section. [J609]

"Study on Q-RAM and Feasible Directions Based Methods for Resource Management in Phased Array Radar Systems"

Our recent progress and results on optimal real-time resource allocation in phased array radar systems are reported. A previously proposed discrete resource allocation approach, the Quality of Service based Resource Allocation Model (Q-RAM), is analyzed and is observed to generate nonoptimal results. We identify the shortcomings of this method and first extend it using the Karush-Kuhn-Tucker (KKT) optimality conditions for the single resource type case. We obtain an algorithm that delivers a globally optimal solution. We later generalize this further for the multiple resource type case. The Q-RAM approach has its origins in the quality-of-service domain and is fundamentally limited to sampled cost functions. The availability of empirically obtained samples of convex tracking performance curves for phased array radar and the feasibility of continuous approximations to these samples lead our study to the consideration of well formulated alternative methods from the optimization literature belonging to the class of methods of feasible directions. In particular we successfully apply the gradient-projection algorithm for the more general multiple resource type case. Our experimental studies using simulated radar performance data (formulated as a calibration data set) show that superior performance can be obtained in achieving closeness to optimality, while also maintaining similar algorithm execution speeds. Performance can even be increased further if additional computational complexity can be tolerated. In particular improvements in closeness to optimality become significant for dense target scenarios with large number of targets. [J610]

"Geodetically Accurate InSAR Data Processor"

We present a new interferometric synthetic aperture radar (InSAR) processing approach that capitalizes on the precise orbit tracking that is available with modern radar satellites. Our method uses an accurate orbit information along with motion-compensation techniques to propagate the radar echoes to positions along a noninertial virtual orbit frame in which the location and focusing equations are particularly simple, so that images are focused without requiring autofocus techniques and are computed efficiently. Motion compensation requires two additional focus correction phase terms that are implemented in the frequency domain. If the images from an interferometric pair or stack are all computed along the same reference orbit, flat-Earth topographic correction is not needed, and image coregistration is simplified, obviating many difficulties that are often encountered in InSAR processing. We process several data sets collected by the ALOS PALSAR instrument and find that the geodetic accuracy of the radar images is 10-20 m, with up to 20 m of additional image distortion needed to align

100 km Ч 100 km scenes with reference digital elevation models. We validated the accuracy by using both known radar corner reflector locations and by the registration of the interferograms with digital maps. The topography-corrected interferograms are free from all geometric phase terms, and they clearly show the geophysical observables of crustal deformation, atmospheric phase, and ionospheric phase. [J611]

"A Doppler Robust Max-Min Approach to Radar Code Design"

This correspondence considers the problem of robust waveform design in the presence of colored Gaussian disturbance under a similarity and an energy constraint. We resort to a max-min approach, where the worst case detection performance (over the possible Doppler shifts) is optimized with respect to the radar waveform under the previously mentioned constraints. The resulting optimization problem is a non-convex Quadratically Constrained Quadratic Program (QCQP) with an infinite number of constraints, which is NP-hard in general and typically difficult to solve. Hence, we propose an algorithm with a polynomial computational complexity to generate a good sub-optimal solution for the aforementioned QCQP. The analysis, conducted in comparison with some known radar waveforms, shows that the sub-optimal solutions by the algorithm lead to high-quality radar signals. [J612]

"A Low Complexity Blind Estimator of Narrowband Polynomial Phase Signals"

Consider the problem of estimating the parameters of multiple polynomial phase signals observed by a sensor array. In practice, it is difficult to maintain a precisely calibrated array. The array manifold is then assumed to be unknown, and the estimation is referred to as blind estimation. To date, only an approximated maximum likelihood estimator (AMLE) was suggested for blindly estimating the polynomial coefficients of each signal. However, this estimator requires a multidimensional search over the entire coefficient space. Instead, we propose an estimation approach which is based on two steps. First, the signals are separated using a blind source separation technique, which exploits the constant modulus property of the signals. Then, the coefficients of each polynomial are estimated using a least squares method applied to the unwrapped phase of the estimated signal. This estimator does not involve any search in the coefficient spaces. The computational complexity of the proposed estimator increases linearly with respect to the polynomial order, whereas that of the AMLE increases exponentially. Simulation results show that the proposed estimator achieves the Cramer-Rao lower bound at moderate or high signal to noise ratio. [J613]

"Estimation of the Backscatter Vertical Profile of a Pine Forest Using Single Baseline P-Band (Pol-)InSAR Data"

The vertical backscatter profile of a pine forest constituted by stands of different height is inverted from a single baseline P-band Pol-InSAR data in order to identify scatterers in the canopy. The proposed approach uses the Gaussian vertical backscatter profile model, which associates an interferometric coherence expression to a vertical scatterers' distribution characterized by relative standard deviation and elevation. The methodology, which uses in situmeasurements of forest height and unbiased ground level estimation, is applied to HV and VV channels, providing accuracy given sufficiently low ground-to-canopy power ratios. Inverted backscatter profiles show maximum power converging toward the basis of the tree crown on highest forests, where the largest branches are located, indicating the high sensitivity of P-band measurements to the forest structure and to the vertical biomass distribution. Over lower stands with larger tree densities, the power peak is located in the upper part of the canopy, which can be explained by a stronger attenuation in the canopy. [J614]

"Obtaining Accurate Ocean Surface Winds in Hurricane Conditions: A Dual-Frequency Scatterometry Approach"

We describe a method for retrieving winds from colocated Ku- and C-band ocean wind scatterometers. The method utilizes an artificial neural network technique to optimize the weighting of the information from the two frequencies and to use the extra degrees of freedom to account for rain contamination in the measurements. A high-fidelity scatterometer simulation is used to evaluate the efficacy of the technique for retrieving hurricane force winds in the presence of heavy precipitation. Realistic hurricane wind and precipitation fields were simulated for three Atlantic hurricanes, Katrina and Rita in 2005 and Helene in 2006, using the Weather Research and Forecasting model. These fields were then input into a radar simulation previously used to evaluate the Extreme Ocean Vector Wind Mission dual-frequency scatterometer mission concept. The simulation produced high-resolution dual-frequency normalized radar cross-section (NRCS) measurements. The simulated NRCS measurements were binned into 5 x 5 km wind cells. Wind speeds in each cell were estimated using an artificial neural network technique. The method was shown to retrieve accurate winds up to 50 m/s even in intense rain. [J615]

"Spectroscopic Calibration Correlation of Field and Lab-Sized Fluorescence LIDAR Systems"

A method has been developed to correlate spectral signatures obtained with various fluorescence LIght Detection And Ranging (LIDAR) systems. A calibrated fluorescence reference target was used to calibrate the spectral response of the LIDAR transmitter channels and obtain their transfer functions. Two LIDAR systems have been spectrally characterized, and corrected signatures for two bioaerosols are presented. The first LIDAR system is the Standoff Integrated Bioserosol Active Hyperspectral Detection field LIDAR developed by Defence R&D Canada. This standoff system uses a 351-nm pulsed laser in a monoaxial design. The second system is a lab-sized aerosol chamber designed to characterize fluorescent aerosols under controlled environmental conditions. The chamber was designed according to classical short-range biaxial LIDAR principles, with the purpose of duplicating the results obtained with field LIDAR systems. Aerosols generated within the chamber are probed by a 355-nm pulsed laser, and autofluorescence spectra are measured with a spectrometer and an intensified charge-coupled device camera. This chamber is used to collect the reference spectra of various fluorescing aerosols and simulants of biological agents. One of the main objectives in using this chamber is to produce and compile a library of instrument-free fluorescing spectra that can be transferred to other LIDAR-based bioaerosol sensors with known optical transfer functions. [J616]

"Evaluation of Aerial Remote Sensing Techniques for Vegetation Management in Power-Line Corridors"

This paper presents an evaluation of airborne sensors for use in vegetation management in power-line corridors. Three integral stages in the management process are addressed, including the detection of trees, relative positioning with respect to the nearest power line, and vegetation height estimation. Image data, including multispectral and high resolution, are analyzed along with LiDAR data captured from fixed-wing aircraft. Ground truth data are then used to establish the accuracy and reliability of each sensor, thus providing a quantitative comparison of sensor options. Tree detection was achieved through crown delineation using a pulse-coupled neural network and morphologic reconstruction applied to multispectral imagery. Through testing, it was shown to achieve a detection rate of 96%, while the accuracy in segmenting groups of trees and single trees correctly was shown to be 75%. Relative positioning using LiDAR achieved root-mean-square-error (rmse) values of 1.4 and 2.1 m for cross-track distance and along-track position, respectively, while direct georeferencing achieved rmse of 3.1 m in both instances. The estimation of pole and tree heights measured with LiDAR had rmse values of 0.4 and 0.9 m, respectively, while stereo matching achieved 1.5 and 2.9 m. Overall, a small number of poles were missed with detection rates of 98% and 95% for LiDAR and stereo matching. [J617]

"Wideband cavity backed slot antenna for automotive monopulse radars"

A wideband cavity backed slot antenna is designed for automotive-borne monopulse radar applications. A rectangular slot is used to realise broad bandwidth; the slot is backed by a cavity, and the vertical walls of the cavity are implemented by discrete vias; and the slot is fed by a microstrip line. The proposed antenna is compact, robust, fully planar and easy to integrate. A two-element array is fabricated and tested. Measured input impedance is matched to 50 Г‚Вї within band [2.61 GHz, 3.44 GHz] (27.5% bandwidth); and monopulse beam-scanning is successfully demonstrated. [J618]

"Joint Detection and Estimation of Multiple Objects From Image Observations"

The problem of jointly detecting multiple objects and estimating their states from image observations is formulated in a Bayesian framework by modeling the collection of states as a random finite set. Analytic characterizations of the posterior distribution of this random finite set are derived for various prior distributions under the assumption that the regions of the observation influenced by individual objects do not overlap. These results provide tractable means to jointly estimate the number of states and their values from image observations. As an application, we develop a multi-object filter suitable for image observations with low signal-to-noise ratio (SNR). A particle implementation of the multi-object filter is proposed and demonstrated via simulations. [J619]

"History of Monopulse Radar in the US"

The history of development of monopulse radar in the US is reviewed herein. Significant techniques that permitted monopulse tracking radars to achieve accurate tracking with high efficiency are discussed, including sum-and-difference antenna feed networks, multi-horn and multi-mode feeds, precision mechanical pedestals, and space-fed arrays. The discussion concentrates on surface-based radars, but many of the techniques apply to airborne radars and missile seekers developed during the same periods. [J620]

"HFSW Radar Model: Simulation and Measurement"

High-frequency surface-wave (HFSW) radars are usually used to remotely measure oceanographic parameters. These systems can also potentially detect targets beyond the conventional microwave radar coverage. In this paper, the backscattered Doppler spectrum made up of the sea clutter, ship echoes, and the background noise has been modeled. Taking into account the propagation and the signal-processing effects, a range-Doppler image has been generated. This model can be used for different purposes like the (theoretical) evaluation of detection performance. This paper gives an overview of the theoretical elements for modeling the backscatter signal. The processing effects on the range-Doppler image and the time-evolving target signature are also introduced. Some of the simulated elements and the obtained range-Doppler images are compared with real data. Finally, from this model, the detection capabilities of HFSW radars are evaluated. [J621]

"Beamforming Through a Circular Pipe for Target Location"

Beamforming through a circular pipe with two open ends is investigated. A formulation is presented for one-way beamforming through a pipe and demonstrated through simulation. One-way beamforming is then extended to two-way beamforming and applied to backscattering data from a target. Backscattering data are processed using beamforming to obtain target azimuth information. With the addition of frequency diversity, a two-dimensional image is obtained. Two-way beamforming is demonstrated through simulation and measurement. [J622]

"Imaging of Fractal Profiles"

In this paper, a model for radar images of fractal (topologically 1-D) profiles is introduced. A twofold approach is followed: on one hand, we analytically solve the problem whenever small-slope profiles are in order; on the other hand, we present a partly analytical and partly numerical setup to cope with the general-slope case. By means of the analytical approach, we evaluate in closed form both the structure function and the power density spectrum of the radar signal. An appropriately smoothed (physical) fractional Brownian model (fBm) process is employed; its introduction is justified by the finite sensor resolution. A fractal scattering model is employed. It is shown that for a fractal profile modeled as an fBm stochastic process, the backscattered signal turns out to be strictly related to the associated fractional Gaussian noise process if a small-slope regime for the observed profile can be assumed. In the analytical-numerical framework, a profile with prescribed fractal parameters is first synthesized; then, fractal scattering methods (applicable to wider slope regimes with respect to the previous case) are employed to compute the signal backscattered toward the sensor. Finally, the power density spectrum of the acquired radar image is estimated. The obtained spectra are favorably compared with the theoretical results, and a parametric study is performed to assess the overall method behavior. [J623]

"Simulating X-Band Interferometric Height in a Spruce Forest From Airborne Laser Scanning"

The aim of this study is to use airborne laser scanning (ALS) data to simulate synthetic aperture radar interferometry (InSAR) elevation data [digital elevation model (DEM)] from the spatial distribution of scatterers. A Shuttle Radar Topography Mission X-band DEM data set and an ALS data set from a spruce-dominated forest area are used. A 3-D grid of voxels is made from the spatial distribution of ALS first echoes. The slant angle penetration rate of the SAR microwaves (PSAR) is simulated to be a function of the vertical ALS penetration rate (PALS), i.e., PSAR= PALS4. The InSAR DEM and heights above the ground are fairly well reproduced by the simulator. A total least squares regression model between the simulated and measured InSAR DEMs has an R2value of 0.99 and a slope of 1: 1. By subtracting the ALS-based terrain heights (digital terrain model), we obtained InSAR heights, which were reproduced with an R2value of 0.78, a slope of 0.96, and a root-mean-square error of 2.3 m. With the simulator, it was demonstrated how a disturbance event would affect the InSAR height. Unfortunately, the relationship was curvilinear and concave, which means that the method is not very sensitive to weak disturbances. This might be partly overcome by using a more vertical incidence angle of the SAR microwaves. The simulator might be used for validation or ground truthing of the InSAR data, as well as gaining understanding of how vegetation changes affect the InSAR data. [J624]

"The IMS 2010 Quiz [JMicrowave Surfing]"

{no data available} [J625]

"An Array Error Estimation Method for Constellation SAR Systems"

In practice, unavoidable array errors, consisting of phase and position errors, significantly degrade the performance of constellation synthetic aperture radar (SAR) systems. Therefore, methods are required to estimate these errors. In constellation SAR systems, the clutter spectrum components within a Doppler bin can be used as calibration sources with known directions. In this letter, it is observed that the steering vectors of the

spectrum components in one Doppler bin are conjugate with those of the spectrum components in its contrary Doppler bin on condition that each SAR operates in side-looking mode and its nominal left coordinate is zero, which is easy to realize. We obtain a new phase error estimation method based on this observation. An array error estimation method, which estimates phase and position errors simultaneously, is proposed via combining the new phase error estimation method with the least squares method for estimating position errors. The advantages of the proposed method include its capability to directly estimate phase and position errors without joint iteration between the estimations of phase and position errors; thus, it performs well, while the conventional method behaves unstably because it may converge to a local optimal solution, when position errors are large. Furthermore, mathematical analysis indicates that the proposed method has less computational load. In addition, computer simulations show that it performs better than the conventional method. The only cost is that it employs twice as many Doppler bins as the conventional method does, which is endurable because there are numerous Doppler bins. [J626]

"Discrete Almost-Symmetric Wave Packets and Multiscale Geometrical Representation of (Seismic) Waves"

We discuss a multiscale geometrical representation of (seismic) waves through a decomposition into wave packets. Wave packets can be thought of as certain localized "fat" plane waves. Here, we construct discrete almost-symmetric 3-D wave packets by using the unequally spaced fast Fourier transform. The resulting discrete transform is unitary, implying that the reconstruction operator is simply the adjoint of the decomposition operator. Another relevant aspect of the discretization scheme is the appearance of parameters that control the tiling of the phase space that corresponds with the dyadic parabolic decomposition, preserving the relative parabolic scaling while adapting to the physical problem at hand. We consider applications in exploration and global seismology, in particular for higher dimensional data regularization, seismic map migration, denoising, directional regularity analysis, and feature extraction. [J627]

"Iterative Bayesian Retrieval of Hydrometeor Content From X-Band Polarimetric Weather Radar"

Dual-polarized weather radars are capable to detect and identify different classes of hydrometeors, within stratiform and convective storms, exploiting polarimetric diversity. Among the various techniques, a model-supervised Bayesian method for hydrometeor classification, tuned for S- and X-band polarimetric weather radars, can be effectively applied. Once the hydrometeor class is estimated, the retrieval of their water content can also be statistically carried out. However, the critical issue of X-band radar data processing, and in general of any attenuating wavelength active system, is the intervening path attenuation, which is usually not negligible. Any approach aimed at estimating hydrometeor water content should be able to tackle, at the same time, path attenuation correction, hydrometeor classification uncertainty, and retrieval errors. An integrated iterative Bayesian radar algorithm (IBRA) scheme, based on the availability of the differential phase measurement, is presented in this paper and tested during the International H2O Project experiment in Oklahoma in 2002. During the latter campaign, two dual-polarized radars, at S- and X-bands, were deployed and jointly operated with closely matched scanning strategies, giving the opportunity to perform experimental comparisons between coincident measurements at different frequencies. Results of the IBRA technique at X-band are discussed, and the impact of path attenuation correction is quantitatively analyzed by comparing hydrometeor classifications and estimates with those obtained at S-band. The overall results in terms of error budget show a significant improvement with respect to the performance with no path attenuation correction. [J628]

"Signal level Simulator for netted text radar waveforms evaluation"

When evaluating the performances of radar waveforms, it is crucial to understand how the signal is affected by multiple interactions with the environment and the system hardware. Analysis of complex radar systems, such as multistatic and netted designs (see Figure 1) is often intractable without the application of a dedicated radar simulation system. Recent research into radar simulation has focused primarily on synthetic aperture radar (SAR) systems [1] and is not entirely applicable to traditional radar systems concerned with the location and tracking of remote targets. A complete simulator has been designed for the accurate simulation of raw returns in complex, multistatic, and netted radars, and is applicable to pulsed and continuous wave (CW) systems, and both active and passive radar systems. The Flexible Simulator for Multistatic Radars (FERS) can be used to simulate radar systems with arbitrary waveforms and arbitrary numbers of receivers, transmitters, and scatterers. Herein, algorithms for the simulation of raw radar return signals are presented, based on interpolation and modification of the transmitted signal and modeling of the radar hardware and environment. The algorithms are expected to be especially valuable for the simulation of emerging radar technologies, such as Passive Coherent Location (PCL) [2], netted radar and phased array radar. Preliminary results, presented herein, suggest that these algorithms can simulate physical systems with excellent accuracy. [J629]

"Applications of passive surveillance radar system using cell phone base station illuminators"

The networks of cell phone base stations not only provide continuous service for mobile communications users but also offer abundant illuminator resources for passive surveillance radar systems. This extensively explores the potential applications of passive surveillance radar using cell phone base station signals for various scenarios such as ground traffic monitoring, coastal and air surveillance, and through-the-wall motion detections. These promising experimental results demonstrated that such systems can be an attractive, low-cost alternative solution for various applications and prospectively as a complement to traditional active radar systems. [J630]

"Ambient vibration testing of bridges by non-contact microwave interferometer"

Recent progress in radar techniques and systems led to the development of an interferometric radar, suitable to the application in dynamic testing and vibration monitoring of civil engineering structures. The main characteristic of the new radar system is the possibility of simultaneously measuring the (static or dynamic) displacement of several points of a structure with high sensitivity. This describes the major characteristics of the microwave interferometer and its application to ambient vibration testing of full-scale bridges. [J631]

"Clear-Cut Detection in Swedish Boreal Forest Using Multi-Temporal ALOS PALSAR Backscatter Data"

An extensive dataset of images acquired by the Advanced Land Observing Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR) is investigated for clear-cut detection in the county of Vajsterbotten, Sweden. Strong forest/non-forest contrast and temporal consistency were found for the Fine Beam Dual HV-polarized backscatter in summer/fall. In consequence of a clear-cut between image acquisitions, the HV-backscatter dropped in most cases between 2 and 3 dB. Thus, a simple thresholding algorithm that exploits the temporal consistency of time series of HV-backscatter measurements has been developed for clear-cut detection. The detection algorithm was applied at pixel level to ALOS PALSAR strip images with a pixel size of 50 m. The performance of the detection algorithm was tested with three different threshold values (2.0, 2.5 and 3.0 dB). The classification accuracy increased from 57.4% to 78.2% for decreasing value of the threshold. Conversely, the classification error increased from 3.0% to 9.7%. For about 90% of the clear-felled polygons used for accuracy assessment the proportion of pixels correctly detected as clear-felled was above 50% when using a threshold value of 2.0 dB. For the threshold values of 2.5 and 3.0 dB the corresponding figures were 80% and 65%, respectively. The total area classified as clear-felled during the time frame of the ALOS PALSAR data differed by 5% compared to an estimate of notified fellings for the same period of time when using a detection threshold of 2.5 dB. The performance of the simple detection algorithm is reasonable when aiming at detecting clear-cuts, whereas there are shortcomings in terms of delineation. [J632]

"Analysis of Spatial Similarities Between NEXRAD and NLDAS Precipitation Data Products"

Precipitation is one of the key inputs for hydrological modeling. Although the Multisensor Precipitation Estimator (MPE) from NEXRAD (Next Generation Radar) and the NLDAS (North American Land Data Assimilation System) precipitation data have been extensively used in various hydrological and climatic studies, there has been no systematic investigation of the spatial similarities and differences between them, based on long-term time series data over a large spatial region. In this study, six years of hourly and daily precipitation time series data from NEXRAD and NLDAS were investigated for their spatial similarities, over a subregion of the Ohio River basin. Three spatial metrics were used: Cohen's Kappa coefficient, Forecast Quality Index (FQI), and displacement-based Forecast Quality Measure (FQM). The three metrics were also applied to the two data products after stratification by season (warm, cold). Results show that significant differences exist between NEXRAD MPE and NLDAS. Analyses and discussions are presented on possible causes of the dissimilarities. In addition, results show that a single metric cannot adequately represent their spatial characteristics. The three metrics are complementary to each other and, when used jointly, can provide a more complete picture of the similarities and differences between the two precipitation products. However, if a single metric is desired, then a more comprehensive one needs to be developed to effectively account for magnitude, distance, shape, and neighborhood effects. [J633]

"Methods for Identifying and Controlling Sonar Clutter"

Three methods for identifying, characterizing, and controlling active sonar clutter are described and demonstrated on broadband, low-frequency (<;1800 Hz) normalized data collected in two range-dependent, shallow-water environments: the Malta Plateau off Sicily and the Stanton Banks off Scotland. One method examines short time-scale clutter persistence to stabilize/minimize coherent propagation effects. A second method correlates strong clutter echoes with the depth-weighted topographic slope (relative to the sonar) to help predict the

significant scatterers. A third method involves moment-based statistical measures [Poisson-Rayleigh-inspired method (PRIM), K-distribution shape parameter, kurtosis] to distinguish between spatially compact and spatially extended clutter objects. As illustrated with the isolation of several anthropogenic objects from widespread topographic clutter on the Malta Plateau, the new Poisson-Rayleigh (P-R)-based method appears to offer some promise in regards to reducing the false alarm rate. [J634]

"Mapping of Sand Layer Thickness in Deserts Using SAR Interferometry"

This paper presents an interferometric synthetic aperture radar (InSAR) system to map the bedrock topography underneath the sand in deserts and arid areas. This is anticipated to greatly increase the efficiency of oil field and ground water exploration as well as environmental and archaeological studies. The proposed system consists of two InSAR subsystems, one operating at Ka-band to map the sand topography and the other operates in the VHF band to map the subsurface topography. The different issues associated with InSAR processing for subsurface mapping are discussed. It is shown that conventional InSAR processing produces unacceptable error in height estimation since it does not account for the refraction and the different propagation velocity in the sand. Thus, a new inversion algorithm is developed which can be used to accurately estimate the bedrock topography for arbitrary sand and bedrock geometries. A sensitivity analysis is then presented to show the effect of the different systematic and random errors. The inversion algorithm is verified experimentally for flat sand case using a scaled model that was implemented in the lab. [J635]

"Target Existence Based Resource Allocation"

Assume an electronically steered antenna (ESA) radar. In between the search mode operations (where the radar completes one scan of the surveillance area), we may optimize performance by judiciously updating individual tracks. The optimization is often translated into the choice of the next track to update. We propose a resource allocation scheme designed to minimize the response time to changing target situation; i.e., confirmation of new tracks following new targets, and termination of tracks without targets. The resource allocation cost is a function of the probability of target existence of individual tracks. Approximative expressions are derived and verified. Simulation results show that resource allocation based on this cost significantly improves the response time of the system to the changes in target situation. As a spurious benefit, some of the sensor time is liberated for other activities. [J636]

"Concrete Moisture Content Measurement Using Interdigitated Near-Field Sensors"

The efficacy of a meander and a circular interdigitated sensor in detecting and measuring the moisture present in wet concrete samples is demonstrated. Analytical, simulation, and measurement results of interelectrode capacitance for samples with different moisture contents show good agreement. As moisture content increases from 0% to 6%, the interelectrode capacitance that predicts the moisture content increases by 126.4% for the meander sensor and 187% for the circular sensor. Regression analysis of the measured data demonstrates that for moisture content less than 6% the relationship between the measured capacitance and the percent moisture content is predominantly linear. [J637]

"Time domain IQ imbalance compensation for wideband wireless systems"

A time domain IQ compensation approach is proposed for wideband application where the IQ imbalance is frequency dependent. The proposed approach relies on known signal such as preamble in orthogonal frequency-division multiplexing (OFDM) signal data frame and radar echoes. Signal correlation property is used for noise elimination and signal frequency spectrum is divided into several sub-bands to deal with frequency-dependent IQ imbalance in wideband scenarios. In order to solve the number of computation increase problem caused by frequency spectrum sub-bands division, complementary code sequences are applied for calculation simplification by exploiting the uncorrelated properties between complementary code matrixes. By comparison with traditional time domain compensation method, the proposed approach exhibits better performance in low signal-to-noise ratio (SNR) and wideband scenarios. [J638]

"A New Strategy to Estimate Local Fringe Frequencies for InSAR Phase Noise Reduction"

A new approach is presented to estimate the fringe frequencies in interferometric synthetic aperture radar (InSAR) phase image. A first-order model is usually used for fringe frequency estimation, but in steep regions or low-correlation regions, it often fails. In this letter, a prefiltered interferogram, obtained by the slope-compensated or conventional mean filter, is divided into small patches and unwrapped separately. Subsequently, we differentiate the local-phase-unwrapping results to obtain the fringe frequencies. Furthermore, the invalid fringe frequencies are eliminated by a statistical threshold. Finally, the interferogram is filtered by compensating the estimated fringe frequencies in the averaging window of the mean filter. The proposed method can obtain

continuous fringe frequency estimation, and it is not constrained by the first-order model. The effectiveness of the proposed approach is verified by the simulated and real InSAR data. [J639]

"Detection of Moving Targets by Focusing in UWB SAR-Theory and Experimental Results"

Moving-target detection in ultrawideband (UWB) synthetic aperture radar (SAR) is associated with long integration time and must accommodate azimuth focusing for reliable detection. This paper presents the theory on detection of moving targets by focusing and experimental results on single-channel SAR data aimed at evaluating the detection performance. The results with respect to both simulated and real data show that the ability to detect moving targets increases significantly when applying the proposed detection technique. The improvement in signal-to-clutter noise ratio, which is a basic requisite for evaluating the performance, reaches approximately 20 dB, using only single-channel SAR data. This gain will be preserved for the case of multichannel SAR data. The reference system for this study is the airborne UWB low-frequency SAR Coherent All RAdio BAnd Sensing II. [J640]

"On the Potential of Kinematic GPR Surveying Using a Self-Tracking Total Station: Evaluating System Crosstalk and Latency"

In this paper, we present an efficient kinematic ground-penetrating radar (GPR) surveying setup using a self-tracking total station (TTS). This setup combines the ability of modern GPR systems to interface with Global Positioning System (GPS) and the capability of the employed TTS system to immediately make the positioning information available in a standardized GPS data format. Wireless communication between the GPR and the TTS system is established by using gain variable radio modems. Such a kinematic surveying setup faces two major potential limitations. First, possible crosstalk effects between the GPR and the positioning system have to be evaluated. Based on multiple walkaway experiments, we show that, for reasonable field setups, instrumental crosstalk has no significant impact on GPR data quality. Second, we investigate systematic latency (i.e., the time delay between the actual position measurement by TTS and its fusion with the GPR data) and its impact on the positional precision of kinematically acquired 2-D and 3-D GPR data. To quantify latency for our kinematic survey setup, we acquired forward-reverse profile pairs across a well-known subsurface target. Comparing the forward and reverse GPR images using three fidelity measures allows determining the optimum latency value and correcting for it. Accounting for both of these potential limitations allows us to kinematically acquire high-quality and high-precision GPR data using off-the-shelf instrumentation without further hardware modifications. Until now, these issues have not been investigated in detail, and thus, we believe that our findings have significant implications also for other geophysical surveying approaches. [J641]

"IEEE Transactions on Microwave Theory and Techniques and Antennas and Propagation Announce a Joint Special Issue on Ultra-Wideband (UWB) Technology"

Before the emergence of ultra-wideband (UWB) radios, widely used wireless communications were based on sinusoidal carriers, and impulse technologies were employed only in specific applications (e.g. radar). In 2002, the Federal Communication Commission (FCC) allowed unlicensed operation between 3.1-10.6 GHz for UWB communication, using a wideband signal format with a low EIRP level (−41.3dBm/MHz). UWB communication systems then emerged as an alternative to narrowband systems and significant effort in this area has been invested at the regulatory, commercial, and research levels. [J642]

"Practical Illumination Uncertainty Assessment i-n Ground-Based Radar Measurements"

The models governing ground-bounce illumination have been well understood for decades. Previously referenced work examined the application of these models to three-dimensional geometries, and showed that illumination variation is a spatially dependent function of frequency. Illumination variation requires knowledge of the target's geometry and scattering characteristics in order to evaluate uncertainty. This paper leverages that work and further develops a short-time Fourier transform (STFT) method to extract frequency-domain scattering characteristics directly from target data. By utilizing at least two antenna heights in two separate measurements, ground-bounce geometries allow for useful target-feature characterization. This enables an assessment of spatial target uncertainty in the image domain, as well as for RCS; it further shows promise for illumination-error mitigation. This paper demonstrates this potential in simulation to support measurements collected at the National RCS Test Facility (NRTF), Holleman AFB, NM. [J643]

"The New Year Quiz [JAP-S Turnstile]"

There are many interesting items that land in my "Turnstile" folder but that, for one reason or another, do not find their way into a column. I thought I would feature some of those tidbits in this short quiz. So, take out a pencil

and start circling your choices. The answers appear elsewhere in this issue. I hope you have as much fun answering the questions as I had picking them. Good luck! [J644]

"Kharkov Joint Chapter Salutes Yakov S. Shifrin on His 90th Birthday"

Life Fellow of the IEEE and founder of the statistical antenna theory, Prof. Yakov Solomonovich Shifrin was born in the town of Mstislavl, Belarus, on April 23, 1920. In 1941, he graduated with honors from the Leningrad State University with a specialty in Physics. Yakov Solomonovich is a man of unbending spirit and morality. He took part in the Second World War. In 1944-1945, he was a commander of radar units. He was the first lecturer on radiolocation with the Sevastopol school of antiaircraft artillery in 1945-1948. The main scientific and pedagogic activity of Yakov Solomonovich was associated with the Artillery Radio Engineering Academy in Kharkov, where he worked from 1948 to 1980. In 1953, he received the degree of candidate of sciences (equivalent of a PhD), and in 1965, he defended a doctoral thesis (DSc). In 1966, he was elected a full professor. From 1951 to 1956, he worked as a lecturer, and from 1956 to 1980, he was Head of the Chair of Antennas and Propagation at this academy. After he retired from the armed forces in 1980, Yakov Solomonovich has been working with the Kharkov National University of Radio Electronics. [J645]

"Antenna Beamwidth Control [JAntenna Designer's Notebook]"

Some methods for controlling antenna beamwidth are briefly proposed for aperture widths approximately equal to one wavelength. They can be used as primary feeds to create fan beams for radar antennas. The mouth modifications can improve the radiation patterns and the matching of the input impedance. This allows narrowing the radiation pattern, and therefore increasing the gain. On the other hand, similar modifications are advantageous for dual orthogonal polarization or octave-frequency-bandwidth operations of aperture antennas, such as horns. The proposed modifications have been performed for a hoghorn antenna. The measurements of the conventional and modified hoghorn designs are compared in detail. [J646]

"MIMO Radar Waveform Design in Colored Noise Based on Information Theory"

In this paper, we consider multiple input multiple output (MIMO) radar waveform design in colored noise. Two information theoretic measures are used as criterions for optimal waveform design under transmitted power constraint. The first one is by maximizing the mutual information between target impulse response and target echoes; the second one is by maximizing the relative entropy between two hypotheses: in the first hypothesis we assume the target is not present in the echoes while in the second hypothesis we assume the target exists in the echoes. We derive optimal solutions for both cases. Interestingly, both optimal solutions require that transmitted waveform should "match" with the target and noise. However, the optimal solutions of the two problems lead to different power allocation strategies. [J647]

"Airborne Collision Avoidance System for low attitude flights using Radio Data System"

Radio Data System (RDS) is a mature technique which has been developed over the past 20 years. Due to the common use of FM radio, the traits of low estate requirement and the convenience in broadcasting, RDS is suitable for use in wireless transmission of large-range and low-load data. This proposes the application of RDS in the Traffic Collision Avoidance System (TCAS) for low altitude flights. The real-time surveillance information from the airport control center of low attitude flights can be wirelessly transmitted in real-time to the RDS receiver in the aircrafts. Because of the low-price of RDS broadcast station and the widespread use of RDS receiver contributed by the application of RDS-TMC for car navigation system in recent years, using RDS as the redundancy communication system in low altitude flights is plausible in almost every aspect, Nevertheless, one thing left to be desired is the slow transferring speed (1187.5 bps) of RDS, which is amended in this research by particularly designed data formats to reduce the information load in each transmission. As a result, the application proposed herein is feasible. [J648]

"A General Characterization for Polarimetric Scattering From Vegetation Canopies"

Current polarimetric model-based decomposition techniques are limited to specific types of vegetation because of their assumptions about the volume scattering component. In this paper, we propose a generalized probability density function based on the nth power of a cosine-squared function. This distribution is completely characterized by two parameters; a mean orientation angle and the power of the cosine-squared function. We show that the underlying randomness of the distribution is only a function of the power of the cosine-squared function. We then derive the average covariance matrix for various different elementary scatterers showing that the result has a very simple analytical form suitable for use in model-based decomposition schemes. [J649]

"Institutional Listings"

{no data available} [J650]

"Target Localization Accuracy Gain in MIMO Radar-Based Systems"

This paper presents an analysis of target localization accuracy, attainable by the use of multiple-input multiple-output (MIMO) radar systems, configured with multiple transmit and receive sensors, widely distributed over an area. The Cramer-Rao lower bound (CRLB) for target localization accuracy is developed for both coherent and noncoherent processing. Coherent processing requires a common phase reference for all transmit and receive sensors. The CRLB is shown to be inversely proportional to the signal effective bandwidth in the noncoherent case, but is approximately inversely proportional to the carrier frequency in the coherent case. We further prove that optimization over the sensors' positions lowers the CRLB by a factor equal to the product of the number of transmitting and receiving sensors. The best linear unbiased estimator (BLUE) is derived for the MIMO target localization problem. The BLUE's utility is in providing a closed-form localization estimate that facilitates the analysis of the relations between sensors locations, target location, and localization accuracy. Geometric dilution of precision (GDOP) contours are used to map the relative performance accuracy for a given layout of radars over a given geographic area. [J651]

"Ultrawideband Filter Technologies"

Following the adoption by the Federal Communications Committee (FCC) in February 2002 [1] of the unlicensed use of ultrawideband (UWB) communications spectrum from 3.1 GHz to 10.6 GHz, there has been increasingly interesting research on UWB techniques by academics and private industry. UWB systems have several advantages: They have a bandwidth of 7.5 GHz, which can support a high transmission data rate (up to 500 Mb/s); they have low energy density over a wideband spectrum generated by short pulse excitation, which not only makes the UWB system difficult to intercept but also minimizes interference by other radio systems; and they have extremely low transmission energy (less than 1.0 mW), which is favorable for hand-held radio systems. UWB techniques have been used for many applications, such as positioning, rescue radar system for rescuing survivors buried under collapsed buildings in many emergency situations, imaging, short-range high-data-rate communication systems, and wireless personal area networks (WPANs) for personal computer and electronic devices. [J652]

"Automated Polar Ice Thickness Estimation From Radar Imagery"

This paper focuses on automating the task of estimating Polar ice thickness from airborne radar data acquired over Greenland and Antarctica. This process involves the identification and accurate selection of the ice sheet's surface location and interface between the ice sheet and the underlying bedrock for each measurement. Identifying the surface and bedrock locations in the radar imagery enables the computation of ice sheet thickness, which is important for the study of ice sheets, their volume, and how they may contribute to global climate change. The time-consuming manual approach requires sparse hand-selection of surface and bedrock interfaces by several human experts, and interpolating between the selections to save time. Two primary methods have been studied in this paper, namely, edge-based and active contour. Results are evaluated and presented using the metrics of time requirements and accuracy. Automated ice thickness estimation results from 2006 and 2007 Greenland field campaigns illustrate that the edge-based approach offers faster processing (seconds compared to minutes), but suffers from a lack of continuity and smoothness aspects that active contours provide. The active contour approach is more accurate when compared to ground truth selections provided by human experts, and has proven to be more robust to image artifacts. It is shown that both techniques offer advantages which could be integrated to yield a more effective system. [J653]

"Improved Hurricane Ocean Vector Winds Using SeaWinds Active/Passive Retrievals"

The SeaWinds scatterometer, onboard the QuikSCAT satellite, infers global ocean vector winds (OVWs); however, for a number of reasons, these measurements in hurricanes are significantly degraded. This paper presents an improved hurricane OVW retrieval approach, known as Q-Winds, which is derived from combined SeaWinds active and passive measurements. In this technique, the effects of rain are implicitly included in a new geophysical model function, which relates oceanic brightness temperature and radar backscatter measurements (at the top of the atmosphere) to the surface wind vector under both clear sky and in the presence of light to moderate rain. This approach extends the useful wind speed measurement range for tropical cyclones beyond that exhibited by the standard SeaWinds Project Level-2B (L2B) 12.5-km wind vector algorithm. A description of the Q-Winds algorithm is given, and examples of OVW retrievals are presented for the Q-Winds and L2B 12.5-km algorithms for ten hurricane overpasses in 2003-2008. These data are also compared to independent surface wind vector estimates from the National Oceanic and Atmospheric Administration Hurricane Research Division's

objective hurricane surface wind analysis technique known as H*Wind. These comparisons suggest that the Q-Winds OVW product agrees better with independently derived H^ Wind analysis winds than does the conventional L2B OVW product. [J654]

"Bench test for measurement of differential RCS of UHF RFID tags"

A bench test for differential radar cross-section (Г‚ВїRCS) measurement is described. The principle is to measure the power difference between the low and high modulation state of the tag and calculate the ratio with the received power. To do this, devices such as an arbitrary generator that replaces the reader, and a real-time spectrum analyser to receive and analyse the signal backscattered by the tag, are used; both devices can be configured in frequency and power. The first measurements are performed manually and the results demonstrate the validity of the proposed method. The automation of the system is carried out in order to make the measurement faster, less hardwork, more precise and more repeatable. [J655]

"Performance Evaluation of Automotive Radars Using Carrier-Phase Differential GPS"

We describe a centimeter-level ground-truth system based on GPS relative positioning. One of the goals of the system is for performance evaluation of automotive radars by creating objective test procedures for the radars. In support of this goal, an effective scheme is used to handle signal attenuation or blockage that leads to the changes of satellite visible map and cycle slip. Multiplatform GPS measurements and low-cost vehicle dynamic sensor data are integrated for vehicle trajectory reconstruction. Experimental results are presented to illustrate the system's actual centimeter-level accuracy and superior performance over Kalman smoothing. The effectiveness of the proposed ground-truth system is demonstrated by evaluating mono-pulse short-range radars whose accuracy is about submeter level. [J656]

"Focused Sessions"

{no data available} [J657]

"Passive and Active L-Band Microwave Observations and Modeling of Ocean Surface Winds"

L-band microwave backscatter and brightness temperature of sea surfaces acquired using the Passive/Active L-band Sensor during the High Ocean Wind campaign are reported in terms of their dependence on ocean surface wind speed and direction. We find that the L-band VV, HH, and HV radar backscatter data increase by 6-7 dB from 5 to 25 m/s wind speed at a 45° incidence angle. The data suggest the validity of Phased Array type L-band Synthetic Aperture Radar (PALSAR) HH model function between 5 and 15 m/s wind speeds, but show that the extrapolation of PALSAR model at above 20 m/s wind speeds overpredicts A0and a1coefficients. There is wind direction dependence in the radar backscatter with about 4 dB differences between upwind and crosswind observations at 24 m/s wind speed for VV and HH. The passive brightness temperatures show about a 5-K change for TVand a 7-K change for THfor a wind speed increasing from 5 to 25 m/s. Circle flight data suggest a wind direction response of about 1-2 K in TVand THat 14 and 24 m/s wind speeds. The L-band microwave data show excellent linear correlation with the surface wind speed with a correlation better than 0.95. The results support the use of L-band radar data for estimating the wind-driven excess brightness temperature of sea surfaces. The data also support the applications of L-band microwave signals for high-resolution (kilometer scale) observation of ocean surface winds under high wind conditions (10-28 m/s). [J658]

"Compressive Stepped-Frequency Continuous-Wave Ground-Penetrating Radar"

Data acquisition speed is an inherent problem of stepped-frequency continuous-wave (SFCW) radars, which may discourage further usage and development of this technology. We propose an emerging paradigm called compressed sensing (CS) to overcome this problem. In CS, a signal can be reconstructed exactly based on only a few samples below the Nyquist rate. Accordingly, the data acquisition speed can be increased significantly. A novel design of an SFCW ground-penetrating radar (GPR) with high acquisition speed is proposed and evaluated. Simulation by a monocycle waveform and actual measurement by a vector network analyzer at a GPR test range indicate the applicability of the proposed system. [J659]

"Design of a substrate integrated waveguide modified R-KR lens for millimetre-wave application"

In this study, a new type of substrate integrated waveguide (SIW) beamforming network (BFN) based on the principle of the modified R-KR lens has been proposed and experimentally verified. Through the detailed analysis of such a structure, a prototype lens with 15 input ports is implemented together with an SIW slot array antenna at 30 GHz, which is able to cover a wide angle of (59, 59) with its 3 dB beam-width. The measured radiation efficiencies of the lens excited at different ports range from 21.6 to 40.8 . This type of BFN takes the

advantages of low profile, low cost and high performance, and may be applied to millimetre-wave mobile communications and radars with beam switching technology. [J660]

"An ISAR Imaging Method Based on MIMO Technique"

With the inverse synthetic aperture radar (ISAR) imaging model, targets should move smoothly during the coherent processing interval (CPI). Since the CPI is quite long, fluctuations of a target's velocity and gesture will deteriorate image quality. This paper presents a multiple-input-multiple-output (MIMO)-ISAR imaging method by combining MIMO techniques and ISAR imaging theory. By using a special M-transmitter N-receiver linear array, a group of Morthogonal phase-code modulation signals with identical bandwidth and center frequency is transmitted. With a matched filter set, every target response corresponding to the orthogonal signals can be isolated at each receiving channel, and range compression is completed simultaneously. Based on phase center approximation theory, the minimum entropy criterion is used to rearrange the echo data after the target's velocity has been estimated, and then, the azimuth imaging will finally finish. The analysis of imaging and simulation results show that the minimum CPI of the MIMO-ISAR imaging method is 1/MNof the conventional ISAR imaging method under the same azimuth-resolution condition. It means that most flying targets can satisfy the condition that targets should move smoothly during CPI; therefore, the applicability and the quality of ISAR imaging will be improved. [J661]

"Initial Position Estimation Using RFID Tags: A Least-Squares Approach"

The GPS has revolutionized how people, vehicles, and objects are positioned. The GPS, however, has limitations. It will only work well where a signal can be received and will not work underground, in tunnels, or even some buildings. Obtaining an accurate position estimate in these areas must therefore use alternate methods that do not rely on GPS. Promising research from the field of robotics provides an alternative approach to positioning, using a technique known as simultaneous localization and mapping (SLAM). The challenge for the SLAM algorithm is that the initial position given to the algorithm must be accurate. This paper investigates the concept of using an array of RF identification (RFID) tags placed at known positions to provide the initial position of the stationary vehicle to the SLAM algorithm. A least-squares (LS)-based position estimator is presented and evaluated in an experiment conducted in an underground potash mine and an indoor environment at the University of Saskatchewan. The estimator's average error is calculated using models with a varied number of parameters. It was found that both environments attain the best results with five model parameters that were obtained from data taken in the same environment. The results suggest that RFID-based positioning, using this LS approach, has the potential to provide relatively accurate and low-cost initial position estimation. [J662]

"Including Spatial Correlations in the Statistical MIMO Radar Target Model"

Previous studies of statistical MIMO radar detection performance have used a target model that consists of a large number of point scatterers located within a rectangular target area. These point scatterers have scattering amplitudes that are complex random variables and are spatially uncorrelated, so that the target is a white noise process in space. Spatial correlations are introduced into the target model in this paper, and the impact of these correlations on MIMO radar system detection performance is analyzed. [J663]

"Semidefinite Relaxation of Quadratic Optimization Problems"

In this article, we have provided general, comprehensive coverage of the SDR technique, from its practical deployments and scope of applicability to key theoretical results. We have also showcased several representative applications, namely MIMO detection, BГ‚Bï shimming in MRI, and sensor network localization. Another important application, namely downlink transmit beamforming, is described in [1]. Due to space limitations, we are unable to cover many other beautiful applications of the SDR technique, although we have done our best to illustrate the key intuitive ideas that resulted in those applications. We hope that this introductory article will serve as a good starting point for readers who would like to apply the SDR technique to their applications, and to locate specific references either in applications or theory. [J664]

"Occupational and Residential Exposures to ELF Magnetic Fields Over a 24-h Period Among a Sample of Urban Populations in Korea"

The objective of this survey is to characterize the extremely low frequency (ELF) personal magnetic field (MF) exposure of the general population in Korea. This is the first-ever personal MF exposure survey done in Korea. The participants of the survey on MF exposure were randomly selected by occupation. The survey was conducted as follows: study participants wore an MF meter for about 25-28 h, and the exposure data were stored in the meter every 4 s. The personal MF exposure meter that was used for this survey was EMDEX-LITE, made by Enertech Consultants, Inc., USA. The participants were asked to record their activities so that MF

exposure can be evaluated for a 24-h period. The personal MF exposure survey has been conducted for about four years, and the total number of participants was 466. To get the 24-h exposure data is one of the main purposes of this survey. The survey also provided an opportunity to analyze exposures corresponding to different types of activities. The exposure was analyzed in separate periods corresponding to the following activities: the entire 24-h period, in bed, at work, and by occupation. Therefore, the database was utilized to analyze the present status of personal MF exposure. [J665]

"Automatic Extraction of Control Points for the Registration of Optical Satellite and LiDAR Images"

A novel method for automatic extraction of control points for the registration of optical images with Light Detection And Ranging (LiDAR) data is proposed. It is based on transformation-invariant detection of salient image disks (SIDs), which determine the location of control points as the centers of the corresponding image fragments. The SID is described by a feature vector, which, in addition to the coordinates and diameter, includes intensity descriptors and region shape characteristics of the image fragment. SIDs are effectively extracted using multiscale isotropic matched filtering-a visual attention operator that indicates image locations with high-intensity contrast, homogeneity, and local shape saliency. This paper discusses the extraction of control points from both natural landscapes and structured scenes with man-made objects. Registration experiments conducted on QuickBird imagery with corresponding LiDAR data validated the proposed approach. [J666]

"C-Band Polarimetric Backscattering Signatures of Newly Formed Sea Ice During Fall Freeze-Up"

A study of the polarimetric backscattering response of newly formed sea ice types under a large assortment of surface coverage was conducted using a ship-based C-band polarimetric radar system. Polarimetric backscattering results and physical data for 40 stations during the fall freeze-up of 2003, 2006, and 2007 are presented. Analysis of the copolarized correlation coefficient showed its sensitivity to both sea ice thickness and surface coverage and resulted in a statistically significant separation of ice thickness into two regimes: ice less than 6 cm thick and ice greater than 8 cm thick. A case study quantified the backscatter of a layer of snow infiltrated frost flowers on new sea ice, showing that the presence of the old frost flowers can enhance the backscatter by more than 6 dB. Finally, a statistical analysis of a series of temporal-spatial measurements over a visually homogeneous frost-flower-covered ice floe identified temperature as a significant, but not exclusive, factor in the backscattering measurements. [J667]

"Reduced-Rank STAP Schemes for Airborne Radar Based on Switched Joint Interpolation, Decimation and Filtering Algorithm"

In this paper, we propose a reduced-rank space-time adaptive processing (STAP) technique for airborne phased array radar applications. The proposed STAP method performs dimensionality reduction by using a reduced-rank switched joint interpolation, decimation and filtering algorithm (RR-SJIDF). In this scheme, a multiple-processing-branch (MPB) framework, which contains a set of jointly optimized interpolation, decimation and filtering units, is proposed to adaptively process the observations and suppress jammers and clutter. The output is switched to the branch with the best performance according to the minimum variance criterion. In order to design the decimation unit, we present an optimal decimation scheme and a low-complexity decimation scheme. We also develop two adaptive implementations for the proposed scheme, one based on a recursive least squares (RLS) algorithm and the other on a constrained conjugate gradient (CCG) algorithm. The proposed adaptive algorithms are tested with simulated radar data. The simulation results show that the proposed RR-SJIDF STAP schemes with both the RLS and the CCG algorithms converge at a very fast speed and provide a considerable SINR improvement over the state-of-the-art reduced-rank schemes. [J668]

"Reducing the Waveform Cross Correlation of MIMO Radar With Space-Time Coding"

Multiple-input-multiple-output (MIMO) radar is attractive for target detection, parameter identification, and target classification due to diversity of waveform and perspective. However, the mutual interference among the waveforms may lead to performance degradation in resolving spatially close returns. In this paper, we consider the use of space-time coding (STC) to mitigate the waveform cross-correlation effects in MIMO radar. First, it turns out that a joint waveform optimization problem can be decoupled into a set of individual waveform design problems. Second, a number of monostatic waveforms can be directly used in a MIMO radar system, which offers flexibility in waveform selection. We provide conditions for the elimination of waveform cross correlation, and discuss four kinds of space time codes. In addition, we also extend the model to partial waveform cross-correlation removal based on waveform set division. Numerical results demonstrate the effectiveness of STC in MIMO radar for waveform decorrelation. [J669]

"Fundamental Limit of Sample Generalized Eigenvalue Based Detection of Signals in Noise Using

Relatively Few Signal-Bearing and Noise-Only Samples"

The detection problem in statistical signal processing can be succinctly formulated: given m (possibly) signal bearing, n -dimensional signal-plus-noise snapshot vectors (samples) and Nstatistically independent n-dimensional noise-only snapshot vectors, can one reliably infer the presence of a signal? This problem arises in the context of applications as diverse as radar, sonar, wireless communications, bioinformatics, and machine learning and is the critical first step in the subsequent signal parameter estimation phase. The signal detection problem can be naturally posed in terms of the sample generalized eigenvalues. The sample generalized eigenvalues correspond to the eigenvalues of the matrix formed by ?whitening? the signal-plus-noise sample covariance matrix with the noise-only sample covariance matrix. In this paper, we prove a fundamental asymptotic limit of sample generalized eigenvalue-based detection of signals in arbitrarily colored noise when there are relatively few signal bearing and noise-only samples. Specifically, we show why when the (eigen) signal-to-noise ratio (SNR) is below a critical value, that is a simple function of n, m, and N, then reliable signal detection, in an asymptotic sense, is not possible. If, however, the eigen-SNR is above this critical value then a simple, new random matrix theory-based algorithm, which we present here, will reliably detect the signal even at SNRs close to the critical value. Numerical simulations highlight the accuracy of our analytical prediction, permit us to extend our heuristic definition of the effective number of identifiable signals in colored noise and display the dramatic improvement in performance relative to the classical estimator by Zhao We discuss implications of our result for the detection of weak and/or closely spaced signals in sensor array processing, abrupt change detection in sensor networks, and clustering methodologies in machine learning. [J670]

"Book Review [Jreviews of "Tools of Radio Astronomy" (WIlson, T.L., et al; 2009)]"

This 515-page book does a very good job of covering the basics of the field for the beginning user of the radio telescopes as well as for their builder. It is quite timely in that it will help signal processors meet the needs of these emerging radio astronomy tools. [J671]

"CALIOP Aerosol Subset Processing for Global Aerosol Transport Model Data Assimilation"

A system for processing Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) satellite-based 0.532 and 1.064 elastic and polarization lidar datasets for global aerosol transport model assimilation is described. A method for constructing one-degree along-track and cloud-free signal composite averages, consistent with Navy Aerosol Analysis and Prediction System (NAAPS) model gridding, using CALIOP Level 1B attenuated backscatter and Level 2 cloud boundary-height products is outlined. Optimal vertical resolutions and relative signal uncertainties for the composite signal averages are described for both day and nighttime measurement scenarios. Depolarization profiles are described for the 0.532 channel as well as attenuated color ratio profiles using 0.532 and 1.064 attenuated backscatter measurements. Constrained by NAAPS model aerosol optical depths, processed attenuated backscatter profiles are inverted to solve for extinction and backscatter coefficients, their ratio, and extinction coefficient profiles which serve as the basis for data assimilation. [J672]

"Permutation Method for ICA Separated Source Signal Blocks in Time Domain"

A new permutation method for ICA (independent component analysis)- based blind separation is presented. The objective here is to concatenate ICA separated signals in adjacent time blocks. The proposed method utilizes the associativity in column vectors of an estimated mixing matrix and a tracking filter. It has advantages of no required array calibration, efficient computation, and real time updatability. These superiorities are highly beneficial for radar or communication system type applications. Furthermore it is shown, by an experiment using radio wave signals, that the proposed permutation algorithm successfully permutes the separated signal blocks. [J673]

"Rapid Evaluation of Airborne Intercept Radar Detection for Swerling I Targets"

A very simple approximation for evaluating the probability of detection of the modes of airborne intercept radars, for use in large scale air engagement simulations, is developed. The approximation has two parameters, the values of which are generated using numerical optimisation. The results are generally applicable to binary integration processing. [J674]

"Hyper Chaotic Logistic Phase Coded Signal and Its Sidelobe Suppression"

A novel hyperchaotic coding scheme and corresponding optimal selection method are proposed to obtain the hyper chaotic logistic phase code (HCLPC) signal, which exhibits great electronic counter-counter measure (ECCM) performance in the presence of digital radio frequency memory (DRFM) repeat jammers and netted radar systems. Similar to the random noise signal, the HCLPC signal has an ideal average ambiguity function

and cross ambiguity function. However, the HCLPC signal can overcome the difficulties of reference signal storage and transmitter-receiver isolation for random signals. High range sidelobe would exist for finite length of transmit signal in practice. The Tikhonov regularization constrained total least squares algorithm (TRCTLSA) is first proposed to range sidelobe suppression of the HCLPC signal when data inaccuracy and white Gaussian noise is taken into account, and a global optimal solution to this algorithm is given. Simulation shows that it has a better sidelobe suppression effect than other ways. When Gaussian-noise variance is less than 0.01, the sidelobe level can decrease to the order of -55 dB, but the signal-to-noise ratio (SNR) loss is less than 0.05 dB. As a digital sidelobe suppression filter procedure, it can be widely used in noise reduction environments, image enhancements, and easily ported to sidelobe suppression applications of other signals as well. [J675]

"NEW: Network-Enabled Electronic Warfare for Target Recognition"

Network-enabled electronic warfare (NEW) is the development of modeling and simulation efforts that explore the advantages and limitations of NEW concepts. The advantages of linking multiple electronic support measures (ESM) and electronic attack (EA) assets to achieve improved capabilities across a networked battle force have yet to be quantified. In this paper, we utilize radar sensors as ESM and EA assets to demonstrate the advantages of NEW in collaborative automatic target recognition (CATR). Signal (waveform) design for radar sensor networks (RSN) in NEW is studied theoretically. The conditions for waveform coexistence and the interferences among waveforms in RSN are analyzed. We apply the NEW to CATR via waveform diversity combining and propose maximum-likelihood (ML)-ATR algorithms for nonfluctuating targets as well as fluctuating targets. Simulation results indicate that our NEW-CATR performs much better than the single sensor-based ATR algorithm for nonfluctuating and fluctuating targets. [J676]

"Maximum Likelihood Angle-Doppler Estimator using Importance Sampling"

A new joint angle-Doppler maximum likelihood estimator (MLE) based on importance sampling (IS) is proposed. The IS method allows one to compute the maximum likelihood estimator in a computationally efficient manner. It is based upon generating random variates using an importance function which approximates the compressed likelihood function. The performance is very close to the Cramer-Rao lower bound (CRLB). The choice of the algorithm parameters, which will affect the estimation performance, is also addressed. With a reasonable parameter choice, even the angles/Dopplers for closely spaced sources can be accurately estimated, whereas conventional subspace methods fail. Comparison with some suboptimal methods demonstrates that the IS method produces better performance at low signal-to-noise (SNR) and/or a small number of snapshots. [J677]

"A Closed Form for the Noncoherent Gain Factor"

A simple closed-form algebraic expression is given for the proportionality factor relating noncoherent integration gain and the number of integrated pulses. [J678]

"Effect of Rain Attenuation on Range Weighting in Weather Radar"

The amplitude analysis of radar signals from rain is refined. Uniform rain return details with amplitude weighting due to 1) range gate straddle losses and 2) rain attenuation within the processed range cell, both respectively and in nonlinear resultant conditions, are considered. The resulting factor is small in magnitude, except in heavy rain and short wavelengths. The factor has a data-dependent analytic form, without a known analytic inverse. A quantitative solution for the reflectivity factor may employ numerical look-up tables parameterized in specific attenuation single parameter coefficients and range gate width. [J679]

"Radar Micro-Doppler Signature Analysis with HHT"

Radar micro-Doppler signature analysis of vibrating targets with the joint time-frequency methods can provide useful information for target detection, classification, and recognition. We employ a well-known method for nonlinear and nonstationary signals, Hilbert-Huang transform (HHT) as a new approach in micro-Doppler analysis. Simulation and experimental results show that it can achieve better performance than the traditional Cohen's class time-frequency methods. [J680]

"Bistatic SAR Experiments With PAMIR and TerraSAR-X-Setup, Processing, and Image Results"

The spatial separation of the transmitter and the receiver in bistatic synthetic aperture radar (SAR) enables a variety of data acquisition geometries to achieve benefits like the increased information content of bistatic SAR data. In the case of hybrid bistatic SAR constellations where the transmitter is spaceborne and the receiver is onboard an aircraft, one has to deal with a huge discrepancy between platform velocities. This paper presents bistatic spaceborne/airborne SAR experiments, where the radar satellite TerraSAR-X is used as a transmitter

and the airborne SAR sensor Phased Array Multifunctional Imaging Radar (PAMIR) of the Fraunhofer Institute for High Frequency Physics and Radar Techniques (FHR) is used as a receiver. Both sensors are equipped with phased-array antennas, which offer the possibility of beam steering and could be used for the first time for the "double sliding spotlight mode." In this mode, the space- and airborne sensors operate with different sliding factors (ratio between footprint and platform velocity). The performance of two different experiments is analyzed, and the novel double sliding spotlight mode is presented. This paper describes the experimental setups, the synchronization system, and the data acquisition. The image results were processed by a modified backprojection algorithm and a frequency-domain algorithm. The analysis of the final bistatic images comprises the spatial resolution and the scattering behavior of selected objects. Parts of the bistatic SAR images are compared with the corresponding monostatic images of PAMIR and TerraSAR-X. It will be shown that hybrid bistatic SAR is a worthwhile and helpful addition to current monostatic SAR. [J681]

"Iterative Method for Nonlinear FM Synthesis of Radar Signals"

The problem of synthesizing a time-domain signal with a given energy spectral density (ESD) often arises in the field of signal processing. Many solutions have been proposed and successfully used over the years. However the problem of synthesizing a time-domain signal with constraints for a given ESD has not been investigated sufficiently. We propose a solution to one such constraint where the amplitude of the complex-valued time-domain signal is required to be unity. This is equivalent to phase modulating a unit amplitude signal, such that its ESD matches a desired energy spectral density. We provide an algorithm for this solution and apply it to a real problem encountered in radars. [J682]

"A new method for blood velocity measurements using ultrasound FMCW signals"

The low peak power of frequency-modulated continuous wave (FMCW) radar makes it attractive for various applications, including vehicle collision warning systems and airborne radio altimeters. This paper describes a new ultrasound Doppler measurement system that measures blood flow velocity based on principles similar to those of FMCW radar. We propose a sinusoidal wave for FM modulation and introduce a new demodulation technique for obtaining Doppler information with high SNR and range resolution. Doppler signals are demodulated with a reference FMCW signal to adjust delay times so that they are equal to propagation times between the transmitter and the receiver. Analytical results suggest that Doppler signals can be obtained from a selected position, as with a sample volume in pulse wave Doppler systems, and that the resulting SNR is nearly identical to that obtained with continuous wave (CW) Doppler systems. Additionally, clutter power is less than that of CW Doppler systems. The analytical results were verified by experiments involving electronic circuits and Doppler ultrasound phantoms. [J683]

"Planar antenna for continuous beam scanning and broadside radiation by selective surface wave suppression"

A printed leaky-wave antenna (LWA) based on a grating of concentric annular microstrip rings fed by a non-directive TM0surface-wave launcher (SWL) is presented for two-sided continuous beam scanning and broadside radiation. By appropriate selection of the grating periodicity TE field distributions can be suppressed over a large bandwidth ensuring efficient TM0leakage and radiation into the far field. Measured results demonstrate a pencil beam at broadside with a 3 dB beamwidth less than 6 at 17.9 GHz. The presented LWA may be useful for radar and surveillance systems where continuous beam scanning through broadside is desired. [J684]

"Nested Arrays: A Novel Approach to Array Processing With Enhanced Degrees of Freedom"

A new array geometry, which is capable of significantly increasing the degrees of freedom of linear arrays, is proposed. This structure is obtained by systematically nesting two or more uniform linear arrays and can provide O(N2) degrees of freedom using only Nphysical sensors when the second-order statistics of the received data is used. The concept of nesting is shown to be easily extensible to multiple stages and the structure of the optimally nested array is found analytically. It is possible to provide closed form expressions for the sensor locations and the exact degrees of freedom obtainable from the proposed array as a function of the total number of sensors. This cannot be done for existing classes of arrays like minimum redundancy arrays which have been used earlier for detecting more sources than the number of physical sensors. In minimum-input-minimum-output (MIMO) radar, the degrees of freedom are increased by constructing a longer virtual array through active sensing. The method proposed here, however, does not require active sensing and is capable of providing increased degrees of freedom in a completely passive setting. To utilize the degrees of freedom of the nested co-array, a novel spatial smoothing based approach to DOA estimation is also proposed, which does not require the inherent assumptions of the traditional techniques based on fourth-order cumulants or quasi stationary signals. As another potential application of the nested array, a new approach to beamforming based on a

nonlinear preprocessing is also introduced, which can effectively utilize the degrees of freedom offered by the nested arrays. The usefulness of all the proposed methods is verified through extensive computer simulations. [J685]

"A Novel Hierarchical Method of Ship Detection from Spaceborne Optical Image Based on Shape and Texture Features"

Ship detection from remote sensing imagery is very important, with a wide array of applications in areas such as fishery management, vessel traffic services, and naval warfare. This paper focuses on the issue of ship detection from spaceborne optical images (SDSOI). Although advantages of synthetic-aperture radar (SAR) result in that most of current ship detection approaches are based on SAR images, disadvantages of SAR still exist, such as the limited number of SAR sensors, the relatively long revisit cycle, and the relatively lower resolution. With the increasing number of and the resulting improvement in continuous coverage of the optical sensors, SDSOI can partly overcome the shortcomings of SAR-based approaches and should be investigated to help satisfy the requirements of real-time ship monitoring. In SDSOI, several factors such as clouds, ocean waves, and small islands affect the performance of ship detection. This paper proposes a novel hierarchical complete and operational SDSOI approach based on shape and texture features, which is considered a sequential coarse-to-fine elimination process of false alarms. First, simple shape analysis is adopted to eliminate evident false candidates generated by image segmentation with global and local information and to extract ship candidates with missing alarms as low as possible. Second, a novel semisupervised hierarchical classification approach based on various features is presented to distinguish between ships and nonships to remove most false alarms. Besides a complete and operational SDSOI approach, the other contributions of our approach include the following three aspects: 1) it classifies ship candidates by using their class probability distributions rather than the direct extracted features; 2) the relevant classes are automatically built by the samples' appearances and their feature attribute in a semisupervised mode; and 3) besides commonly used shape and texture features, a new texture operator, i.e., loca--l multiple patterns, is introduced to enhance the representation ability of the feature set in feature extraction. Experimental results of SDSOI on a large image set captured by optical sensors from multiple satellites show that our approach is effective in distinguishing between ships and nonships, and obtains a satisfactory ship detection performance. [J686]

"A Monte Carlo Study of Altimeter Pulse Returns and the Electromagnetic Bias"

The electromagnetic (EM) bias is an important error term in sea-surface height estimation from satellite radar altimetry. While the EM bias has been studied extensively, previous studies have utilized hydrodynamic and EM models that require an a priori separation of the sea surface into "long" and "short" waves that are then treated separately. This paper presents a study of the EM bias that avoids this decomposition by employing a Monte Carlo procedure with numerical nonlinear hydrodynamic simulations coupled with numerical physical-optics methods for EM scattering from the sea surface. Due to the computational complexity of the approach, only long-crested surfaces (i.e., 2-D scattering problems) are considered. The formulation of the physical-optics model utilized is presented, along with a derivation of the standard Brown model for the long-crested surface case for comparison. The simulated pulse returns generally are in good agreement with the Brown model using the specular surface height probability density function. However, the influence of the EM frequency on the EM bias obtained is much smaller than that reported from satellite observations. Predicted biases are also examined as the range of length scales included in the surface profile is varied, in order to determine any apparent cutoff or length-scale separations that occur. It is found that the bias continues to increase as additional short waves are included in the surface spectrum, although a saturation occurs for surface length scales shorter than the EM wavelength. [J687]

"Height Retrieval of Isolated Buildings From Single High-Resolution SAR Images"

Detection of man-made structures in urban areas, in terms of both geometric and electromagnetic features, from a single, possibly high resolution (HR), synthetic aperture radar (SAR) image is a highly interesting open challenge. Within this framework, a possible approach for the extraction of some relevant parameters, describing the shape and materials of a generic building, is proposed here. The approach is based on sound electromagnetic models for the radar returns of each element of the urban scene. A fully analytical representation of electromagnetic returns from the scene constituents to an active microwave sensor is employed. Some possible applications of feature extractions from real SAR images, based on the aforementioned approach, have already been presented in the literature as first examples of potentiality of a model-based approach, but here, the overall theory is analyzed and discussed in depth, to move to general considerations about its soundness and applicability, and the efficiency of further applications may be derived. For the sake of conciseness, although the proposed approach is general and can be applied for the retrieval of different scene parameters (in principle, anyone contributing to the radar return), we focus here on the extraction of the building

height, and we assume that the other parameters are either a prioriknown (e.g., electromagnetic properties of the materials) or have been previously retrieved from the same SAR image (e.g., building length and width). An analysis of the sensitiveness of the height retrieval to both model inaccuracies and errors on the knowledge of the other parameters is performed. Some simulation examples accompany and validate the solution scheme that we propose. [J688]

"Canonical Scattering Feature Models for 3D and Bistatic SAR"

This paper develops three-dimensional (3D), bistatic parametric models that describe canonical radar scattering responses of several geometric objects. These models find use in inverse scattering-based processing of high-frequency radar returns. Canonical feature models are useful for extracting geometry from synthetic-aperture radar (SAR) scattering measurements and as feature primitives for automatic target recognition (ATR) and scene visualization. Previous work has considered monostatic feature models for two-dimensional (2D) radar processing; we extend this work to consider bistatic and 3D radar apertures. In the work presented here, we generalize geometric theory of diffraction (GTD) solutions for several scattering mechanisms in a plane. Products of these planar mechanisms in azimuth and elevation are used to produce 3D bistatic scattering models for six canonical shapes: a rectangular plate, dihedral, trihedral, cylinder, top-hat, and sphere. The derived models are characterized by a small number of parameters, and are shown to agree with results obtained from high-frequency, asymptotic scattering simulations. [J689]

"Development and Initial Observation of High-Resolution Volume-Scanning Radar for Meteorological Application"

A new high-resolution Doppler radar, called Ku-band broadband radar (BBR), with fast scanning capability for meteorological application has been developed. Due to the new system design, the BBR can accurately measure the radar reflectivity factor with a range resolution of several meters and a time resolution of 55 s per volume scan from the nearest range of 50 m to 15 km for 10-W power using pulse compression. In this paper, the basic concepts, configuration, and signal processing of the BBR are described. In the initial observation, the observation accuracy of reflectivity is evaluated using Joss-Waldvogel disdrometer (JWD). As a result, the reflectivity of the BBR is in fairly good agreement with that of JWD. In addition, in the spiral observation, a fine structure of a thunderstorm obtained by the BBR is presented. [J690]

"CFAR detection of range-spread target in white Gaussian noise using waveform entropy"

A detection scheme for a range-spread target in white Gaussian noise is developed. The detector is based on waveform entropy of the arithmetic average of multiple successive high-resolution range profiles, and has the precious property of a constant false-alarm rate (CFAR). The proposed detector is compared with the conventional detectors based on measured data, and good performance is reported. [J691]

"Nonparametric detection of frequency modulated signals using fractional Fourier transform"

A detection scheme for unknown nonlinear frequency modulated signals in white Gaussian noise is developed using the fractional Fourier transform and two-dimensional order-statistic filter. The simulation experiment and comparison with other methods available are shown, and the effectiveness of the proposed method is reported. [J692]

"Time-Reversal Ground-Penetrating Radar: Range Estimation With Cramйr-Rao Lower Bounds"

In this paper, first, a new range-estimation technique using time reversal (TR) for ground-penetrating-radar (GPR) applications is presented. The estimator is referred to as the TR/GPR range estimator. The motivation for this paper comes from the need of accurately estimating the location of underground objects such as landmines or unexploded ordinance for safe clearance. Second, the Cramer-Rao lower bound (CRLB) for the performance of the TR/GPR range estimator is derived and compared with the CRLB for the conventional matched filter (MF). The CRLB analysis shows that the TR/GPR range estimator has the potential to achieve higher accuracy in estimating the location of the target than that of the conventional MF estimator. Third, the proposed TR/GPR estimator is tested using finite-difference time-domain simulations, where the surface-based reflection GPR is modeled using an electromagnetic transverse-magnetic (TM) mode formulation. In our simulations, the TR/GPR estimator outperforms the conventional MF approach by up to 5-dB reduction in mean square error at signal-to-noise ratios ranging from -20 to 20 dB for dry-soil environments. [J693]

"Low Probability of Intercept Antenna Array Beamforming"

A novel transmit array beamforming approach is introduced that offers low probability of intercept (LPI) for

surveillance radar systems employing phased array antennas. Radar systems are often highly visible to intercept receivers due to the inherent two-way versus one-way propagation loss. In this paper, the traditional high-gain antenna beam scanned across a search region is replaced with a series of low-gain, spoiled beams. Keeping the transmit antenna gain low reduces the radar visibility, but the radar's antenna performance remains unchanged as the original high-gain beam can be formed by processing the set of spoiled beams. Large transient power density radiated in a traditional scan is replaced with low power density persistently radiated at the target throughout the scan time. The detection performance of the radar is not affected since the total energy on the target is the same. Derivation of the complex weights to synthesize the high-gain patterns from the low-gain basis patterns is presented for both one-way and two-way beam patterns. [J694]

"Micro-Doppler parameter estimation from a fraction of the period"

Radar micro-Doppler (m-D) signatures are of great potential for identifying properties of unknown targets. All the techniques developed for extracting m-D features for the past decade rely primarily on the assumption that the time series of the signal contains at least one oscillation or more during the coherent integration time or imaging time. However, many applications in real-world scenarios involve short duration signals and often require the detection and the estimation of m-D characteristics. Short duration signals may contain only a fraction of an oscillation. In this study, the authors develop two techniques to estimate the m-D parameters from a fraction of the period. In these scenarios, the coherent integration will cover only 1/4 and 1/2 of the oscillation. The performance of the proposed methods are evaluated using both synthetic and experimental data. [J695]

"Editorial Time-frequency approach to radar detection, imaging, and classification"

One of the central problems in exploiting the radar data is the analysis of a time series. The problem at hand is how to extract the information present in the data and use it to its full potential. Traditionally, radar signals have been analysed in either the time or the frequency domain. The Fourier Transform is at the heart of a wide range of techniques that are generally used in radar data analysis and processing. However, the change of frequency content with time is one of the main features we generally observe in radar data. As a result of this change of frequency content with time, radar signals belong to the class of non-stationary signals. The analysis of non-stationary signals requires a technique that extends the notion of a global frequency spectrum to a local frequency description. Joint time-frequency analysis using time-frequency transforms has improved the analysis of non-stationary signals by revealing time-varying information embedded in signals. [J696]

"Model-Based Weather Radar Remote Sensing of Explosive Volcanic Ash Eruption"

Microphysical and dynamical features of volcanic ash clouds can be quantitatively monitored by using ground-based microwave weather radars. These systems can provide data for determining the ash volume, total mass, and height of eruption clouds. In order to demonstrate the unique potential of this microwave active remote-sensing technique, the case study of the eruption of Augustine Volcano in Alaska in January 2006 is described and analyzed. Volume scan data, acquired by a NEXRAD WSR-88D S-band ground-based weather radar, are processed to automatically classify and estimate eruptive cloud particle concentration. The numerical results of the coupled model Z-reflectivity from Active Tracer High resolution Atmospheric Model (ATHAM), including particle aggregation processes and simulation of radar reflectivity from the ATHAM microphysical model, are exploited to train the inversion algorithm. The volcanic ash radar retrieval based on the ATHAM algorithm is a physical-statistical approach based on the backscattering microphysical model of volcanic cloud particles (hydrometeors, ash, and aggregates), used within a Bayesian classification and optimal regression algorithm. A sensitivity analysis is carried out to evaluate the overall error budget. The evolution of the Augustine eruption is discussed in terms of radar measurements and products, pointing out the unique features, the current limitations, and future improvements of radar remote sensing of volcanic plumes. [J697]

"MIMO Radar Detection and Adaptive Design Under a Phase Synchronization Mismatch"

We consider the problem of target detection for multi-input multi-output radar with widely separated antennas in the presence of a phase synchronization mismatch between the transmitter and receiver pairs. Such mismatch often occurs due to imperfect knowledge of the locations and local oscillator characteristics of the antennas. First, we introduce a data model using a von Mises distribution to represent the phase error terms. Then, we employ an expectation-maximization algorithm to estimate the error distribution parameter, target returns, and noise variance. We develop a generalized likelihood ratio test target detector using these estimates. Based on the mutual information between the radar measurements and received target returns (and hence the phase error), we propose an algorithm to adaptively distribute the total transmitted energy among the transmitters. Using Monte Carlo simulations, we demonstrate that the adaptive energy allocation, increase in the phase information, and realistic measurement modeling improve the detection performance. [J698]

"An End-to-End Error Model for Classification Methods Based on Temporal Change or Polarization Ratio of SAR Intensities"

This paper aims at defining the expression of the probability of error of classification methods using a synthetic aperture radar (SAR) intensity ratio as a classification feature. The two SAR intensities involved in this ratio can be measurements from different dates, polarizations, or, also possibly, frequency bands. Previous works provided a baseline expression of the probability of error addressing the two-class problem with equal a prioriclass probabilities and no calibration error. This study brings up a novel expression of the error, providing the possibility to assess the effect of class probabilities and calibration errors. An extended expression is described for the n-class problem. The effect of calibration errors such as channel gain imbalance, radiometric stability, and crosstalk is assessed in the general case. The results indicate that, for the applications under study, channel gain imbalance is usually not a decisive parameter, but radiometric stability is more critical in methods based on the temporal change. Crosstalk has a negligible effect in the case of copolarizations. The impacts of other system parameters, such as ambiguity ratio, time-lapse between repeat-pass orbits, spatial resolution, and number of looks, are illustrated through a set of assumptions on the backscattering values of the considered classes. The model is validated by comparing some of its outputs to experimental results calculated from the application of rice fields mapping methods on real data. This error model constitutes a tool for the design of future SAR missions and for the development of robust classification methods using existing SAR instruments. [J699]

"Sensitivity of X-, C-, and L-Band SAR Backscatter to Burn Severity in Mediterranean Pine Forests"

Synthetic aperture radar (SAR) data at X-, C-, and L-bands have been investigated to determine the relationship between backscatter and forest burn severity over three sites in Spain. The dependence of SAR backscatter on local incidence angle and environmental conditions has been analyzed. At HH and VV polarizations, the backscatter increased with burn severity for X- and C-bands, whereas it decreased for L-band. Cross-polarized (HV) backscatter decreased with burn severity for all frequencies. Determination coefficients were used to quantify the relationship between radar backscatter and burn severity for given intervals of local incidence angle. For X- and C-band copolarized data, higher determination coefficients were observed for slopes oriented toward the sensors, whereas for cross-polarized data, the determination coefficients were higher for slopes oriented away from the sensor. At L-band, the association strength of cross-polarized data to burn severity was high for all local incidence angles. C- and L-band cross-polarized backscatter showed better potential for burn severity estimation in the Mediterranean environment when the local incidence angle is accounted for. The small dynamic range observed for X-band data could hinder its use in forests affected by fires. [J700]

"Impact of Radarsat-2 SAR Ultrafine-Mode Parameters on Stereo-Radargrammetric DEMs"

The new high-resolution mode of Radarsat-2 was evaluated for digital elevation model (DEM) generation using stereo-radargrammetry with Toutin's 3-D physical model as part of the Canadian Space Agency's programs. In addition, the impact of radar parameters on stereo-extracted DEMs was evaluated. Three stereo pairs using different radar parameters (resolutions; HH and VV polarizations; slant and ground range; image spacing) from ultrafine-mode Radarsat-2 data acquired over a test site north of Quebec City, Canada, were formed to generate DEMs, which were thus compared to 15-cm-accurate lidar elevation data. Results showed a good accuracy for the three stereo-extracted DEMs: less than 0.8 m for the horizontal positioning and around 3 m (1) for the elevation on bare soils, with small 3-D biases (2-3 m). The HH stereo pair in slant-range format slightly but consistently achieved the best results. [J701]

"Passive Coherent Location as Cognitive Radar"

Cognitive Radar describes a generic radar system that is capable of adapting its transmission waveforms and cooperation with other sensors in order to achieve superior detection, recognition, and tracking of targets. For example, the sensors of a cognitive radar system might use the illumination signals to carry broadcast data, allowing the sharing of target information. Herein, we postulate that it would be possible to implement a cognitive version of Passive Coherent Location (PCL) which has much in common with the broad cognitive radar concept, but adapts only to the waveforms it senses in the environment, and exploits those that are most useful to it for target detection. In addition, it would model the terrain to improve coverage and provide countermeasures against direct signal saturation. By its name, PCL does not transmit, but relies on emissions from other radiating systems, such as broadcast services, other radars, cellular radio, WiFi, and so on. It is clear that such a system, consisting of multiple, cooperating receivers, can achieve excellent performance in the presence of deliberate jamming, difficult terrain, and attempts at target stealth. In the civilian radar domain, the technology offers opportunities for bandwidth conservation. [J702]

"A Situation-Adaptive Lane-Keeping Support System: Overview of the SAFELANE Approach"

Going beyond standard lane-departure-avoidance systems, this paper addresses the development of a system that is able to deal with a large set of different traffic situations. Its foundation lies on a thoroughly constituted environment detection through which a decision system is built. From the output of the decision module, the driver is warned or corrected through suited actuators that are coupled to control strategies. The input to the system comes from cameras, which are supplemented by active sensors (such as radar and laser scanners) and vehicle dynamic data, digital road maps, and precise vehicle-positioning data. In this paper, the presented system design is divided into three layers: the perception layer, which is responsible for the environment perception, and the decision and action layers, which are responsible for evaluating and executing actions, respectively. [J703]

"Acceleration-independent along-track velocity estimation of moving targets"

In the study a new method for along-track velocity estimation of moving targets is presented. This method exploits the along-track interferometric phase ramp of a range-compressed moving target signal between two or more receiving channels. The slope of this phase ramp is mainly influenced by the along-track velocity but not by accelerations. Hence, acceleration-independent along-track velocity estimation is feasible. A verification of the proposed method is performed by using both simulations and real two- and four-channel X-band data acquired with DLR's E-SAR and F-SAR system. [J704]

"Time-Delay Multiplexing of Two Beams in a Terahertz Imaging Radar"

We demonstrate a time-delay multiplexing technique that doubles the frame rate of a 660-690-GHz imaging radar with minimal additional instrument complexity. This is done by simultaneously projecting two offset, orthogonally polarized radar beams generated and detected by a common source and receiver. Beam splitting and polarization rotation is accomplished with a custom designed waveguide hybrid coupler and twist. A relative time lag of approximately 2 ns between the beams' waveforms is introduced using a quasi-optical delay line, followed by spatial recombination using a selectively reflective wire grid. This delay is much longer than the approximately 20-ps time-of-flight resolution of the 30-GHz bandwidth radar, permitting the two beams' reflected signals from a compact target to be easily distinguished in digital post-processing of the single receiver channel. [J705]

"Investigation of the Slow-Wave Properties of a Dielectric-Lined Azimuthally Periodic Circular Waveguide for TWT"

An improved slow-wave structure (SWS), i.e., a dielectric-lined azimuthally periodic circular waveguide (DLAP-CW) that is a modified form of a conventional dielectric-lined circular waveguide (DL-CW), is proposed. The slow-wave characteristics are studied by the spatial harmonics method. Analytical solutions for the dispersion characteristics and interaction impedance are derived. The complicated dispersion equations have numerically been solved with MATLAB, and the results agree well with simulation results obtained from a high-frequency structure simulator. The effects of the SWS parameters on the RF characteristics are investigated. SWS parameters include the dielectric constant and the thickness and location of the metal rods. It is shown that selecting the appropriate thickness and location of the metal rods increases the interaction impedance with only slight influence on the dispersion characteristics (with the dielectric constant held fixed). Furthermore, the DLAP-CW and the conventional DL-CW are compared, and the results validate that the DLAP-CW has the potential for significantly higher interaction impedance at higher frequencies, potentially resulting in a higher gain traveling-wave-tube circuit. [J706]

"Detection of Spatially Correlated Gaussian Time Series"

This work addresses the problem of deciding whether a set of realizations of a vector-valued time series with unknown temporal correlation are spatially correlated or not. For wide sense stationary (WSS) Gaussian processes, this is a problem of deciding between two different power spectral density matrices, one of them diagonal. Specifically, we show that for arbitrary Gaussian processes (not necessarily WSS) the generalized likelihood ratio test (GLRT) is given by the quotient between the determinant of the sample space-time covariance matrix and the determinant of its block-diagonal version. Furthermore, for WSS processes, we present an asymptotic frequency-domain approximation of the GLRT which is given by a function of the Hadamard ratio (quotient between the determinant of a matrix and the product of the elements of the main diagonal) of the estimated power spectral density matrix. The Hadamard ratio is known to be the GLRT detector for vector-valued random variables and, therefore, what this paper shows is how frequency-dependent Hadamard ratios must be merged into a single test statistic when the vector-valued random variable is replaced

by a vector-valued time series with temporal correlation. For bivariate time series, the derived frequency domain detector can be rewritten as a function of the well-known magnitude squared coherence (MSC) spectrum, which suggests a straightforward extension of the MSC spectrum to the general case of multivariate time series. Finally, the performance of the proposed method is illustrated by means of simulations. [J707]

"Adaptive tomographic sensors for below ground imaging"

Herein, ground penetrating radar and tomography are combined to detect and identify hidden targets, such as underground facilities and bard and deeply buried targets. Past experiences in below-ground imaging is described, current measurement results are presented, and future plans are discussed. [J708]

"A New Vector Waveform Inversion Algorithm for Simultaneous Updating of Conductivity and Permittivity Parameters From Combination Crosshole/Borehole-to-Surface GPR Data"

We have developed a new full-waveform groundpenetrating radar (GPR) multicomponent inversion scheme for imaging the shallow subsurface using arbitrary recording configurations. It yields significantly higher resolution images than conventional tomographic techniques based on first-arrival times and pulse amplitudes. The inversion is formulated as a nonlinear least squares problem in which the misfit between observed and modeled data is minimized. The full-waveform modeling is implemented by means of a finite-difference time-domain solution of Maxwell's equations. We derive here an iterative gradient method in which the steepest descent direction, used to update iteratively the permittivity and conductivity distributions in an optimal way, is found by cross-correlating the forward vector wavefield and the backward-propagated vectorial residual wavefield. The formulation of the solution is given in a very general, albeit compact and elegant, fashion. Each iteration step of our inversion scheme requires several calculations of propagating wavefields. Novel features of the scheme compared to previous full-waveform GPR inversions are as follows: 1) The permittivity and conductivity distributions are updated simultaneously (rather than consecutively) at each iterative step using improved gradient and step length formulations; 2) the scheme is able to exploit the full vector wavefield; and 3) various data sets/survey types (e.g., crosshole and borehole-to-surface) can be individually or jointly inverted. Several synthetic examples involving both homogeneous and layered stochastic background models with embedded anomalous inclusions demonstrate the superiority of the new scheme over previous approaches. [J709]

"A Novel Strategy for Radar Imaging Based on Compressive Sensing"

Radar data have already proven to be compressible with no significant losses for most of the applications in which it is used. In the framework of information theory, the compressibility of a signal implies that it can be decomposed onto a reduced set of basic elements. Since the same quantity of information is carried by the original signal and its decomposition, it can be deduced that a certain degree of redundancy exists in the explicit representation. According to the theory of compressive sensing (CS), due to this redundancy, it is possible to infer an accurate representation of an unknown compressible signal through a highly incomplete set of measurements. Based on this assumption, this paper proposes a novel method for the focusing of raw data in the framework of radar imaging. The technique presented is introduced as an alternative option to the traditional matched filtering, and it suggests that the new modes of acquisition of data are more efficient in orbital configurations. In this paper, this method is first tested on 1-D simulated signals, and results are discussed. An experiment with synthetic aperture radar (SAR) raw data is also described. Its purpose is to show the potential of CS applied to SAR systems. In particular, we show that an image can be reconstructed, without the loss of resolution, after dropping a large percentage of the received pulses, which would allow the implementation of wide-swath modes without reducing the azimuth resolution. [J710]

"Probing Waveform Synthesis and Receiver Filter Design"

Probing waveform synthesis and receive filter design play crucial roles in achievable performance for many active sensing applications, including radar, sonar, medical imaging, and communications (channel estimation and spread spectrum). A flexible receive filter design approach can be used to compensate for missing features of the probing waveforms, at the costs of lower signal-to-noise ratio (SNR) and higher computational complexity. A well-synthesized waveform, meaning one with good auto- and cross-correlation properties, can reduce computational burden at the receiver and improve performance. In this article, we will highlight the interplay between waveform synthesis and receiver design. We will provide a tutorial review of recent novel, cyclic approaches to single and multiple waveform designs. Both aperiodic and periodic correlations will be considered. We show that by making use of fast Fourier transforms (FFTs), we can now efficiently design sequences that were previously impossible to synthesize. Furthermore, we will provide an overview of some advanced techniques for receiver design, including data-independent instrumental variables (IV) filters and a data-adaptive iterative approach. We will show how these designs can significantly outperform conventional techniques in

various active sensing applications. [J711]

"Receiver Design for MIMO Radar Range Sidelobes Suppression"

Multiple-input multiple-output (MIMO) radar transmits multiple-coded signals. In matched filter receiver, coded signals are required to have very good auto- and cross-correlation properties. These conditions are difficult to fulfill simultaneously when the lengths of the codes are short and there are many transmit antennas. In this correspondence, a receive filter matrix is designed using quadratic optimization method. The integrated correlations between the transmitted codes and the receive filter matrix in the area around zero shift are constrained under a prescribed level and the output noise power is minimized. A closed form solution is obtained. This integrated sidelobe level (ISL) method is computationally more efficient compared with the peak sidelobe level (PSL) method. [J712]

"Compression of Medical Sensor Data [JExploratory DSP]"

Over the course of the last 20 years, compression has evolved from a somewhat esoteric domain of mathematics and computer science into a ubiquitous consumer electronics technology. Given the prevalence and success of speech, audio, image, and video compression algorithms in consumer electronics, it is surprising that many high-speed digital signal processing (DSP) systems such as wireless infrastructure, radar processing, and medical imaging sensor subsystems have until recently not considered compression as an alternative for reducing data acquisition bandwidth and storage bottlenecks. This article describes sensor compression for medical transducers that is an integral part of the high-speed DSP transport and storage infrastructure itself, and compressing and decompressing hundreds or thousands of sensor channels in real time. While we certainly acknowledge the benefits of compressing medical images that are output from image reconstruction, our goal is to describe the benefits of compressing medical sensor data before image reconstruction. When combined with low-cost, off-the-shelf computer and networking components, sensor compression reduces the costs of the medical imaging data acquisition, transport, and storage infrastructure. By reducing medical imaging equipment bill of material (BOM) costs, integrated medical sensor compression and decompression will ultimately reduce the cost of medical care. [J713]

"Multi-target localisation in bistatic MIMO radar"

An algorithm for multi-target localisation in bistatic multiple-input multiple-output (MIMO) radar is presented. The directions of arrival (DOAs) of targets can be estimated via ESPRIT by means of the rotational factor produced from two receive subarrays with the corresponding directions of departure (DODs) being paired automatically via the signal subspace. Numerical examples show the effectiveness of the proposed method. [J714]

"Along-track interferometric sar imaging based on distributed compressed sensing"

For synthetic aperture radar (SAR), imaging based on compressed sensing (CS) can reconstruct the target scene with a reduced number of collected samples. But for a multi-channel along-track interferometric (ATI) SAR, the number of samples required could also be huge even though the CS processing is adopted. In this reported work, distributed compressed sensing (DCS) is introduced into ATI SAR. The ATI SAR based on DCS can achieve good performance and requires even fewer samples than that based on CS. [J715]

"Angle estimation in MIMO radar using reduced-dimension capon"

The problem of direction of departure and direction of arrival estimation for multiple-input multiple-output (MIMO) radar is discussed, and a reduced-dimension Capon algorithm is derived. The proposed algorithm which only requires one-dimension search, can avoid the high computational cost within the two-dimension Capon (2D-Capon) algorithm. It is illustrated that the algorithm has slightly better performance than the 2D-Capon algorithm. Simulation results verify the usefulness of the algorithm. [J716]

"Balance of power"

Researchers at TriQuint Semiconductor in the US have developed a GaN high electron mobility transistor (HEMT) on Si substrate that can deliver an X-band power performance comparable to that of a standard GaN on SiC device. It has the highest power added efficiency (PAE) ever achieved for these devices: 65 at 10 GHz, and this result makes GaN on Si technology an attractive, cost-effective solution for several military and commercial applications, such as radar and wireless communications in the S- to X-band range (2-12 GHz). [J717]

"Adaptive sparse grid method for RCS estimation of object with uncertain shape"

Presented is an adaptive sparse grid method to efficiently estimate the radar cross section (RCS) of a 2D cylinder with uncertain holes, as well as uncertain locations, sizes and number of the holes. This model has been applied extensively in microwave engineering, e.g. frequency selective surface (FSS). Stochastic collocation method is employed to solve the resulting stochastic differential equation. The Gauss-Patterson formula is used in the sparse grid method. The adaptive sparse grid method is based on Richardson extrapolation. Numerical results show the proposed method works very well. [J718]

"Radiometric, Geometric, and Image Quality Assessment of ALOS AVNIR-2 and PRISM Sensors"

The Advanced Land Observing Satellite (ALOS) was launched on January 24, 2006, by a Japan Aerospace Exploration Agency (JAXA) H-IIA launcher. It carries three remote-sensing sensors: 1) the Advanced Visible and Near-Infrared Radiometer type 2 (AVNIR-2); 2) the Panchromatic Remote-Sensing Instrument for Stereo Mapping (PRISM); and 3) the Phased-Array type L-band Synthetic Aperture Radar (PALSAR). Within the framework of ALOS Data European Node, as part of the European Space Agency (ESA), the European Space Research Institute worked alongside JAXA to provide contributions to the ALOS commissioning phase plan. This paper summarizes the strategy that was adopted by ESA to define and implement a data verification plan for missions operated by external agencies; these missions are classified by the ESA as third-party missions. The ESA was supported in the design and execution of this plan by GAEL Consultant. The verification of ALOS optical data from PRISM and AVNIR-2 sensors was initiated 4 months after satellite launch, and a team of principal investigators assembled to provide technical expertise. This paper includes a description of the verification plan and summarizes the methodologies that were used for radiometric, geometric, and image quality assessment. The successful completion of the commissioning phase has led to the sensors being declared fit for operations. The consolidated measurements indicate that the radiometric calibration of the AVNIR-2 sensor is stable and agrees with the Landsat-7 Enhanced Thematic Mapper Plus and the Envisat MEdium-Resolution Imaging Spectrometer calibration. The geometrical accuracy of PRISM and AVNIR-2 products improved significantly and remains under control. The PRISM modulation transfer function is monitored for improved characterization. [J719]

"Adaptive Waveform Design for Separated Transmit/Receive ULA-MIMO Radar"

The colocated uniform linear array (ULA) multiple-input multiple-output (MIMO) radar has been demonstrated to provide enhanced performance in theory. Similar to a bistatic radar, performance of the separated transmit/receive (STR) ULA-MIMO radar is affected not only by the transmitted multiple orthogonal waveforms, but also by the position of the target. In this correspondence, the ambiguity function of the STR-ULA-MIMO radar is investigated and the corresponding range-velocity ambiguity function (RVAF) is deduced. The range and velocity resolution of RVAF for the STR-ULA-MIMO radar is discussed. Because the shape of RVAF for the STR-ULA-MIMO radar is related to the position of the target, a new algorithm for adaptively designing the orthogonal frequency-hopping waveforms according to the position of the target is proposed. This algorithm improves the range and velocity resolution and the integrated sidelobe level (ISL) of the matched filter output at the corresponding position. [J720]

"Performance Analysis of Optimized Medium Access Control for Wireless Sensor Network"

In this work, we carried out the performance analysis of Optimized Medium Access Control (MAC) Protocol for the wireless sensor network. This MAC protocol solves the energy inefficiency taking nodes latency into consideration based on the network traffic. It achieves high-energy efficiency under wide range of traffic loads and is able to adjust itself to improve the delay performance when the network traffic load is high. [J721]

"A Rao Test With Enhanced Selectivity Properties in Homogeneous Scenarios"

This correspondence focuses on the design of a selective receiver for homogeneous scenarios. To this end, at the design stage it is assumed that the cell under test contains a noise-like interferer in addition to thermal noise, clutter, and to the possible signal of interest; a set of secondary data, free of signal components, is available: such data share a common covariance matrix that is equal to that of thermal noise plus clutter in the cell under test. Under the above assumptions, an adaptive detector implementing the RAO test is designed. A preliminary performance assessment, conducted assuming that the cell under test and the secondary data share one and the same covariance matrix of the overall disturbance (including possible noise-like interferers), shows that the newly proposed detector can provide enhanced rejection capabilities with respect to its natural competitor (the W-ABORT). It can also outperform the W-ABORT for matched signals. [J722]

"Estimating Surface Water Speeds With a Single-Phase Center SAR Versus an Along-Track Interferometric SAR"

Synthetic aperture radar (SAR) single-aperture systems are designed to image fixed scenes. Dual-antenna along-track interferometric (ATI) SAR systems are designed to detect moving targets and estimate their motion parameters. Although SAR systems are not designed to characterize moving targets, for localized targets, such as vehicles or ships, this problem has been addressed in the literature with some success. Distributed moving targets are hard to characterize, even for ATI systems. Estimating surface water speeds is an ideal example of this since the water returns are generated from weak returns randomly distributed in both time and space. The question asked here is can one measure surface water speeds with a single-phase center SAR system? The answer presented is a qualified yes, with the aid of an upper bound on the water speed, but not with the same accuracy as an ATI system. This upper bound and the collection geometry provide design criteria for the filtering of the phase information. Time-frequency (TF) methods provide another speed estimate as well as a rough profile of the speed across the water channel. A robust nonparametric TF method was developed and applied to estimate the speed. Comparisons between the ATI estimate and single-phase estimates are made using data from an X-band ATI-SAR system. [J723]

"Resolution Enhancement for Inversed Synthetic Aperture Radar Imaging Under Low SNR via Improved Compressive Sensing"

The theory of compressed sampling (CS) indicates that exact recovery of an unknown sparse signal can be achieved from very limited samples. For inversed synthetic aperture radar (ISAR), the image of a target is usually constructed by strong scattering centers whose number is much smaller than that of pixels of an image plane. This sparsity of the ISAR signal intrinsically paves a way to apply CS to the reconstruction of high-resolution ISAR imagery. CS-based high-resolution ISAR imaging with limited pulses is developed, and it performs well in the case of high signal-to-noise ratios. However, strong noise and clutter are usually inevitable in radar imaging, which challenges current high-resolution imaging approaches based on parametric modeling, including the CS-based approach. In this paper, we present an improved version of CS-based high-resolution imaging to overcome strong noise and clutter by combining coherent projectors and weighting with the CS optimization for ISAR image generation. Real data are used to test the robustness of the improved CS imaging compared with other current techniques. Experimental results show that the approach is capable of precise estimation of scattering centers and effective suppression of noise. [J724]

"Very High Resolution Spaceborne SAR Tomography in Urban Environment"

Synthetic aperture radar tomography (TomoSAR) extends the synthetic aperture principle into the elevation direction for 3-D imaging. It uses stacks of several acquisitions from slightly different viewing angles (the elevation aperture) to reconstruct the reflectivity function along the elevation direction by means of spectral analysis for every azimuth-range pixel. The new class of meter-resolution spaceborne SAR systems (TerraSAR-X and COSMO-Skymed) offers a tremendous improvement in tomographic reconstruction of urban areas and man-made infrastructure. The high resolution fits well to the inherent scale of buildings (floor height, distance of windows, etc.). This paper demonstrates the tomographic potential of these SARs and the achievable quality on the basis of TerraSAR-X spotlight data of urban environment. A new Wiener-type regularization to the singular-value decomposition method-equivalent to a maximum a posteriori estimator-for TomoSAR is introduced and is extended to the differential case (4-D, i.e., space-time). Different model selection schemes for the estimation of the number of scatterers in a resolution cell are compared and proven to be applicable in practice. Two parametric estimation algorithms of the scatterers' elevation and their velocities are evaluated. First 3-D and 4-D reconstructions of an entire building complex (including its radar reflectivity) with very high level of detail from spaceborne SAR data by pixelwise TomoSAR are presented. [J725]

"Tomographic SAR Inversion by -Norm Regularization-The Compressive Sensing Approach"

Synthetic aperture radar (SAR) tomography (TomoSAR) extends the synthetic aperture principle into the elevation direction for 3-D imaging. The resolution in the elevation direction depends on the size of the elevation aperture, i.e., on the spread of orbit tracks. Since the orbits of modern meter-resolution spaceborne SAR systems, like TerraSAR-X, are tightly controlled, the tomographic elevation resolution is at least an order of magnitude lower than in range and azimuth. Hence, super-resolution reconstruction algorithms are desired. The high anisotropy of the 3-D tomographic resolution element renders the signals sparse in the elevation direction; only a few pointlike reflections are expected per azimuth-range cell. This property suggests using compressive sensing (CS) methods for tomographic reconstruction. This paper presents the theory of 4-D (differential, i.e., space-time) CS TomoSAR and compares it with parametric (nonlinear least squares) and nonparametric (singular value decomposition) reconstruction methods. Super-resolution properties and point localization accuracies are demonstrated using simulations and real data. A CS reconstruction of a building complex from TerraSAR-X spotlight data is presented. [J726]

"Role of Land-Water Classification and Manning's Roughness Parameter in Space-Borne Estimation of Discharge for Braided Rivers: A Case Study of the Brahmaputra River in Bangladesh"

The proposed Surface Water and Ocean Topography (SWOT) mission will provide global, space-based estimates of water elevation, its temporal change, and its spatial slope for terrestrial water bodies. Using derivations of water slope from the Shuttle Radar Topography Mission (SRTM) elevation data, river bathymetry and Manning's equation, the potential of SWOT for discharge estimation of large braided rivers in humid climates, such as the Brahmaputra river, was found to be promising (Jung, in Earth Surface Processes and Landforms, 2010). In this study we extend the work on assessing SWOT for braided rivers to understand the sensitivity of two river hydraulic parameters to discharge estimation: 1) section factor (AR2/3) derived from land-water classification and in situ river bathymetry and 2) Manning's roughness coefficient. For braided rivers, the first parameter, is intimately dependent on how braided rivers are classified of the multiple channels (water) and in-stream braided bars (land) that consequently dictates the accuracy of wetted perimeter and area of flow estimation from water elevation data. We show that the use of the minimum water elevation data at a river cross section minimizes estimation of section factor which consequently minimizes outlier discharge estimation reported in the Jung study. We also show that by treating roughness coefficient "flexible" as a calibration parameter, discharge estimation from SRTM elevation data can be further improved through trial and error manual optimization. Our sensitivity study illustrates the value of treating section factor and roughness coefficient as calibration parameters for data assimilation systems that use SWOT observables to estimate river discharge in braided rivers. [J727]

"Polarimetric SAR Data in Land Cover Mapping in Boreal Zone"

This paper compares ALOS PALSAR fully polarimetric and dual-polarized data in the application area of land cover mapping. To assure versatile comparison of the data, different classification methods and different features of data are used. Two of the classification methods used are based on supervised classification and two on unsupervised classification. Polarimetric data are used in three ways: (1) as fully polarimetric data; (2) features calculated from fully polarimetric data; and (3) intensity data of selected channels. Combinations of six (water, field, sparse forest, dense forest, peat land, and urban areas), five, four, and three classes were used for classification. Fully polarimetric data gave better results (87.5%-84.7% with three classes; open land areas, forest, and water) than intensity data only (83.6%-78.6%), but the differences in the overall accuracies between the methods were not more than 7.6%. Kappa coefficients of agreement are moderate for all the classifications. Supervised classification can be expected to perform better than unsupervised classification, given that the training areas can be selected accurately. Dual polarization data were found to be an attractive alternative in cases where fully polarimetric data are not available or it is of low resolution. With intensities of selected polarimetric features, it was possible to obtain a high classification accuracy as with fully polarimetric data. This also opens possibilities for nonspecialist users to benefit from polarimetric information in classification. [J728]

"An Analytical Method of Updating the Range Derivatives and a Simple Image Registration Method for the MSR-Based Range Doppler Algorithm"

Based on the method of series reversion, Neo developed a quite accurate range Doppler algorithm (RDA). In performing this RDA, the range derivatives need to be updated along the range. In this letter, first, we will give an analytical method to update the range derivatives for this RDA. The proposed method mainly exploits two points the first is the introduction of a reference vector on the ground plane of the bistatic geometry, and the second is the use of the principle of series reversion. Second, based on this new method of updating the range derivatives, we present a simple image registration method for mapping the focused image onto the ground plane, which needs a 1-D interpolation only in the range direction. Third, a motion compensation method is also proposed. [J729]

"Radiometric Calibration of the Advanced Wind Scatterometer Radar ASCAT Carried Onboard the METOP-A Satellite"

The Advanced Wind Scatterometer (ASCAT) is a six-beam spaceborne radar instrument designed to measure wind fields over the oceans. An ASCAT instrument is carried by each of the three METOP satellites. The ASCAT calibration strategy is described and detailed results are presented concerning the radiometric calibration achieved. [J730]

"A Neural Network Technique for Improving the Accuracy of Scatterometer Winds in Rainy Conditions"

We exhibit a technique for improving wind accuracy in Ku-band ocean wind scatterometers in the presence of rain. The technique is autonomous in that it only makes use of measurements made by the scatterometer itself, so that no colocation of an external data set (e.g., rain radiometers) is required to perform the correction. The only inputs to the technique are the normalized radar cross-section measurements for each wind vector cell, the cross-track distance of the cell as a proxy for measurement geometry, and the nominal retrieved wind vector for the cell without rain correction. This last input is used to avoid modifying winds not contaminated by rain. The technique was applied to QuikSCAT data for the month of January 2008, resulting in a marked improvement to rainy data. For data that were determined to be rain contaminated by the Jet Propulsion Laboratory rain flag, the rms speed error with respect to National Data Buoy Center buoy winds improved from 8.9 to 3.5 m/s for colocations within 25 km. The rms speed error in rain also improved when compared with the European Centre Medium-Range Weather Forecast winds from 7 to 3 m/s. Data that were not flagged as rain contaminated were not significantly changed, despite the fact that the technique does not make use of the rain flag. The technique was able to distinguish between rain-contaminated wind cells and rain-free wind cells and to substantially improve the wind speed accuracy of the former using QuikSCAT data alone without recourse to any external information about the extent of the rain. [J731]

"Space-time clutter rejection and target passive detection using the APES method"

A new method to reject ground clutter using the Amplitude and Phase EStimation (APES) method is proposed. The theoretical approach is followed by the application of this method to the rejection of such an interference in the frame of a bistatic passive radar using digital video broadcasting-terrestrial (DVB-T) transmitters. [J732]

"Adaptive waveform design for range-spread target tracking"

Suboptimal waveform design based on the wide sense stationary-uncorrelated scattering target impulse response model is proposed, which reduces the minimum mean square error of estimation. Simulation results show that the waveform designed by the proposed method performs better than the traditional waveform. [J733]

"Chirp Multiplication by Four Wave Mixing for Wideband Swept-Frequency Sources for High Resolution Imaging"

We present an analysis and demonstration of the doubling of the chirp rate and total chirp bandwidth of a frequency chirped optical signal by the process of four-wave mixing in a non-linear optical medium. The effects of chromatic dispersion and input power on the maximum achievable output bandwidth are analyzed, and a dispersion compensation technique for phase matching is described. The doubling of an input linear frequency sweep of 100 GHz/1 ms in a highly nonlinear optical fiber is experimentally demonstrated. Further, it is proposed that a cascaded implementation of the four-wave mixing process leads to a geometric increase in the bandwidth of the frequency chirp. With an electronically tuned chirped laser at the input stage, this process can be used to generate extremely wideband swept frequency sources with no moving parts, for applications in high-speed and high-resolution optical imaging and spectroscopy. [J734]

"Estimation of micro-motion parameters based on micro-Doppler"

Micro-Doppler has played an important role in describing the micro-motion of a radar target. After analysing the characteristics of micro-Doppler induced by typical micro-motions, a technique based on time-frequency transform and Hough transform is introduced, to extract the modes and estimate the parameters of multiple frequency modulation components in micro-Doppler simultaneously, which can describe the properties of radial micro-motion. Experiments show the performance of estimation algorithm with simulating radar data. [J735]

"Micro-Doppler analysis of a rotating target in synthetic aperture radar"

Rotating targets cause phase modulation of the azimuthal phase history of a synthetic aperture radar (SAR) system. The phase modulation may be seen as a time-dependent micro-Doppler (m-D) frequency. This study presents two approaches for extracting m-D features from SAR images. In order to extract m-D features from SAR images, the time domain radar return is decomposed in two separate ways. One is based on wavelet decomposition in which the returned signal is decomposed into a set of components that are represented at different wavelet scales. The components are then reconstructed by applying the inverse wavelet transform. This wavelet approach has been used in previous m-D analysis work for an inverse SAR (ISAR) system, and it is presented here in the extraction of m-D features for a SAR system. The second approach is based on adaptive chirplet decomposition combined with time-frequency analysis. This new approach is introduced as an alternative to the wavelet approach of decomposing the SAR radar return. The results from the wavelet and adaptive chirplet decomposition proxcedures are compared, and the chirplet-based approach establishes itself as a viable alternative. The chirplet-based method of m-D extraction has been successfully applied to SAR data scene

collected by the US Navy APY-6 radar. [J736]

"Analysis of Wind Turbines Blockage on Doppler Weather Radar Beams"

The split-step solution to the parabolic wave equation describing beam propagation permits examination of the signal degradation in a Doppler weather radar caused by wind turbines blockage under general atmospheric conditions and at arbitrary transmitter and receiver configurations. At radar wavelengths, an understanding of turbine and terrain obscuration effects is essential for deciding the reliability of radar measurements affected by blockage. [J737]

"Dual-frequency Doppler radars for indoor range estimation: Cramer-Rao bound analysis"

Single frequency Doppler radars are effective in distinguishing moving targets from stationary targets, but suffer from inherent range ambiguity. With a dual-frequency operation, a second carrier frequency is utilised to overcome the range ambiguity problem. In urban sensing applications, the dual-frequency approach offers the benefit of reduced complexity, fast computation time and real-time target tracking. The authors consider a single moving target with three commonly exhibited indoor motion profiles, namely, constant velocity motion, accelerating target motion and micro-Doppler (MD) motion. RF signatures of indoor inanimate objects, such as fans, vibrating machineries and clock pendulums, are characterised by MD motion, whereas animate translation movements produce linear FM Doppler. Cramer-Rao bounds (CRBs) for the parameters defining indoor target motions under dual-frequency implementations are derived. Experimental data are used to estimate MD parameters and to validate the CRBs. [J738]

"Time-frequency-based detection of fast manoeuvring targets"

The time-frequency representation (TFR) is a powerful tool for analysis of non-stationary signals. In the past decades, TFRs have been primarily devoted to the analysis tasks in the sense that they were introduced so as to depict time-frequency structure of time-varying signals and non-stationary processes in the time-frequency plane. Also, there has been a permanent interest in tackling decision problems by means of TFRs. In this study the authors, present a time-frequency-based detection scheme in the high-frequency surface-wave radar (HFSWR) for the detection of manoeuvring air targets in the presence of noise. Performance of the proposed method is evaluated by using both synthetic and experimental data. In addition, the proposed time-frequency detection scheme is examined in detail with various signal-to-noise ratio. This time-frequency-based detection method is then compared to the Fourier-based detector. Results clearly demonstrate that the time-frequency-based detector can significantly improve detection performance in the HFSWR, as well as add new physical insight, compared to the conventional Fourier-based detector, currently used by HFSWRs. [J739]

"Multistatic micro-Doppler radar signatures of personnel targets"

This study extends the theory of the micro-Doppler effect into the multistatic domain, and considers how the multistatic micro-Doppler signature (μ-DS) will affect radar automatic target recognition (ATR). Real multistatic μ-DS of personnel targets are examined and their nature compared with theory and simulated results. It is demonstrated that the use of multistatic μ-DSs would increase the robustness of radar ATR systems to the problem of self-occlusion, where the target obscures itself. Redundancy in the multistatic μ-DS is identified, and how this may reduce the data fusion demands of multi-aspect classifiers is discussed. Also, information theory is used to demonstrate that the multistatic μ-DS contains more target information than the monostatic case. This result leads to the prediction that multi-aspect μ-DS-based radar ATR would have improved performance compared to single-aspect solutions. [J740]

"Estimation of micro-motion parameters based on cyclostationary analysis"

A method to describe and estimate the characteristics of target with micro-motions based on cyclostationary theory is proposed in this study. The radar signal returned from a target with vibration or rotation can be modelled as cyclostationary, and a method based on cyclic statistics is designed to estimate the frequency and amplitude of the vibration or rotation. The experiments showed the performance of the proposed method under different signal noise ratios with simulated radar data. [J741]

"Feature Selection in AVHRR Ocean Satellite Images by Means of Filter Methods"

Automatic retrieval and interpretation of satellite images is critical for managing the enormous volume of environmental remote sensing data available today. It is particularly useful in oceanography and climate studies for examination of the spatio-temporal evolution of mesoscalar ocean structures appearing in the satellite images taken by visible, infrared, and radar sensors. This is because they change so quickly and several images of the

same place can be acquired at different times within the same day. This paper describes the use of filter measures and the Bayesian networks to reduce the number of irrelevant features necessary for ocean structure recognition in satellite images, thereby improving the overall interpretation system performance and reducing the computational time. We present our results for the National Oceanographic and Atmospheric Administration satellite Advanced Very High Resolution Radiometer (AVHRR) images. We have automatically detected and located mesoscale ocean phenomena of interest in our study area (North-East Atlantic and the Mediterranean), such as upwellings, eddies, and island wakes, using an automatic selection methodology which reduces the features used for description by about 80%. Finally, Bayesian network classifiers are used to assess classification quality. Knowledge about these structures is represented with numeric and nonnumeric features. [J742]

"Analysis of radar human gait signatures"

The authors develop methods for the time-frequency (TF) analysis of human gait radar signals. In particular the authors demonstrate how knowledge of different motion classes can be obtained via a Markov chain model of state transitions based on the TF envelope structure associated with the motion sequence being analysed. The class-conditional knowledge thus obtained allows us to effectively extract the motion curves associated with different body parts via a non-parametric partial tracking algorithm that is coupled with an optimum Gaussian g-Snake modelling of the TF structure. The optimum segmentation of the TF structure into different half-cycles as well as the determination of the initial Doppler control points (corresponding to each half-cycle) is facilitated by a dynamic programming algorithm wherein the associated cost function involves a mean-square minimisation of the best quadratic fit to each segment together with a sparsity prior that enables us to control the smoothness of the approximation space in which the time series being analysed is effectively projected. Finally, the authors describe some of the limitations of our approach and point out future research directions that can overcome some of the difficulties associated with the complex interaction between the inherently non-linear dynamics of human gait motion and radar systems. [J743]

"Secure cognitive mobile hotspot"

The paper presents a novel consumer device that acts as a cognitive mobile hotspot to provide ubiquitous secure wireless WAN and LAN connectivity while on the move. The mobile hotspot acts as a gateway and integrates VHF/UHF radios with multiple wireless WAN and LAN technologies. The device supports GPRS, EDGE, WCDMA, CDMA2000 and WiMAX as WAN interfaces for long range communication and 802.11, Bluetooth and VHF/UHF interfaces for short range communication. The cognitive controller in the device seamlessly switches the WAN interfaces to provide optimum connectivity and Quality of Service parameters to the LAN devices and VHF/UHF radio links. In applications where nodes are fully mobile, the cognitive mobile hotspot acts a centroid by adjusting its position dynamically and provides a complete mobile backbone for optimum connectivity to mobile devices in a heterogeneous environment. The unique device opens a new paradigm of mobile backbone and seamless switching between multiple wireless broadband technologies and integration of wireless LAN and VHF/UHF interfaces. The device finds applications in vehicle area networks, mobile branch offices, mobile healthcare, media & broadcasting, sporting competitions, trade fairs, exhibitions and mission critical applications like flood relief operations and disaster recovery. [J744]

"Scatterers characterisation in radar imaging using joint time-frequency analysis and polarimetric coherent decompositions"

Classical radar imaging generally considers targets as set of isotropic independent sources with a constant response in the measured frequency band. Nevertheless, new radar capabilities, in terms of signal bandwidth and angular excursion, may challenge this bright point model. Studies based on multidimensional time-frequency (TF) analysis, describing the angular and frequency behaviour of a scene-s reflectivity, showed that some scatterers may have anisotropic and dispersive responses. Polarisation diversity is an interesting additional source of information in radar imaging, and provides indicators closely linked to some geometric and electromagnetic properties of the observed objects. In this study, a fully polarimetric TF analysis is proposed for radar imaging (SAR, ISAR) that characterises the anisotropic and dispersive behaviour of the polarimetric response of deterministic targets. This method is based on the hyper-image concept, which describes the response of scatterers as a function of the observation angle, the emitted frequency and polarimetric canonical behaviours. Polarimetric hyper-images point out that non-stationary behaviours can be related to physical properties of the target (geometrical shape, relative orientation) and allow a better understanding of the scattering mechanisms. This polarimetric hyper-image representation is then used to detect non-stationary scatterers and to classify their behaviour. [J745]

"Time-orthogonal waveform diversity and joint domain localised algorithm for distributed aperture

radars"

Distributed aperture radars represent an interesting solution for target detection in strong interference environments. Distributed apertures provide improved angular resolution or are able to view a target from multiple look-angles, thereby exploiting scintillation. However, because of the large distances between array elements, both target and interfering sources are in the near field of the antenna array. Furthermore, because of the relative motion between antenna elements and interference sources, the clutter Doppler frequency is not stationary. Recent works have demonstrated the benefits of combining frequency diversity and space-time adaptive processing (STAP) for distributed aperture radars. In this study a new waveform diversity system model is developed. Using orthogonal signalling, the receivers can treat the incoming signals independently, solving several bistatic problems instead of the initial multistatic problem. The authors also apply adaptive techniques to counteract the range dependency of the clutter Doppler frequency. In particular, the authors apply the joint domain localised algorithm, specifically chosen because of its need for only limited secondary data. [J746]

"An Optimal Basis of Band-Limited Functions for Signal Analysis and Design"

This paper studies signal concentration in the time and frequency domains using the general constrained variational method of Franks. The minimum k th (k = 0, 2, 4,...) moment time-duration measure for band-limited signals is formulated. A complete, orthonormal set of band-limited functions in L2([-W,W]) with the minimum fourth-moment time-duration measure is obtained. Numerical investigations of our optimal 4th moment functions show: 1) less energy concentration in the main lobe than the prolate spheroidal wave functions (PSWF); 2) higher energy concentration in the main lobe than Gabor's function; and 3) a larger main lobe than both PSWF and Gabor. Applications for our basis functions include: 1) radar systems and high resolution communication systems, and 2) representation and approximation to any band-limited signal in a given time interval. [J747]

"Coherence improving algorithm for airborne multichannel SAR-GMTI"

The study develops an algorithm to improve coherence for the multichannel airborne along-track synthetic aperture radar (SAR), which can be used for ground moving target indication (GMTI) by comparing two SAR images obtained from different channels. The turbulent aircraft motion, beam pattern difference and frequency response difference that may degrade the coherence are discussed in detail. The aircraft motion error is firstly estimated and corrected based on the range compressed data. After focusing on the beam pattern differences and the receive channel imbalance are compensated using the two two-dimensional (2-D) adaptive filters, the first in the range-Doppler domain and the second in the range-frequency azimuth-time domain. It is shown that using the coherence improving algorithm the coherence of SAR complex image pairs can be improved greatly. The effectiveness of the algorithm is demonstrated with real data acquired by a Chinese X-band multichannel airborne SAR-GMTI system. [J748]

"Measurement and comparative analysis of clutter for GSM and UMTS passive radars"

Passive radars have been known to the scientific community since their first application as a system to detect bombers by means of shortwaves radiated by radio broadcasting towers in 1935, although they lately raised a renewed interest among researchers for some specific features that make them more appealing than classic active radar systems. In fact, having the transmitter and receiver located at two different positions, and the adoption of signals carrying other kinds of information such as GSM (either classical or the 1800/1900 MHz DCS version) or UMTS waveforms, makes passive radar virtually undetectable and economically advantageous. A measurement system used to characterise the clutter from a GSM/DCS and UMTS-based passive radar is presented. The main objective is to study the statistical properties of the clutter signals, find theoretical models fitting the measured clutter data and analyse the differences between the modulated carriers of the two different standards. [J749]

"Signal-to-clutter ratio enhancement in bistatic very high frequency (VHF)-band SAR images of truck vehicles in forested and urban terrain"

Multiple scattering is often a dominating scattering mechanism in VHF-band SAR, in particular in scenes including forested and urban terrain. Most important in this context is multiple scattering generated by double- or triple-bounce scattering from structures with orthogonal corners which often dominate for monostatic SAR geometries. Examples include double-bounce scattering from vertical tree stems or building walls on horizontal ground. In such situations, bistatic SAR may offer a significant advantage compared to monostatic SAR by choosing a suitable bistatic imaging geometry. We give experimental results which show increased signal-to-clutter ratio in bistatic VHF-based SAR (28-73 MHz). Results show that the signal-to-clutter ratio of a vehicle truck in a background of forest and urban clutter increases by up to 10 dB when the broadside bistatic elevation angle increases from 4 to 20Г‚В°. The results indicate that significant improvement in detection performance can

be expected for vehicle-sized objects in forest and urban terrain by using bistatic geometries in VHF-band SAR. [J750]

"Passive bistatic noise radar using DVB-T signals"

This study presents a new approach to passively detect targets using noise-like emitters of opportunity. This method combines the Wiener filtering to achieve clutter rejection and a proposed adaptation to noise-like signals of the amplitude and phase estimation (APES) method. This theoretical approach is confirmed by the detection of a helicopter by a bistatic radar using a digital video broadcasting terrestrial (DVB-T) transmitter. [J751]

"Cubature Kalman Filtering for Continuous-Discrete Systems: Theory and Simulations"

In this paper, we extend the cubature Kalman filter (CKF) to deal with nonlinear state-space models of the continuous-discrete kind. To be consistent with the literature, the resulting nonlinear filter is referred to as the continuous-discrete cubature Kalman filter (CD-CKF). We use the Ito-Taylor expansion of order 1.5 to transform the process equation, modeled in the form of stochastic ordinary differential equations, into a set of stochastic difference equations. Building on this transformation and assuming that all conditional densities are Gaussian-distributed, the solution to the Bayesian filter reduces to the problem of how to compute Gaussian-weighted integrals. To numerically compute the integrals, we use the third-degree cubature rule. For a reliable implementation of the CD-CKF in a finite word-length machine, it is structurally modified to propagate the square-roots of the covariance matrices. The reliability and accuracy of the square-root version of the CD-CKF are tested in a case study that involves the use of a radar problem of practical significance; the problem considered herein is challenging in the context of radar in two respects- high dimensionality of the state and increasing degree of nonlinearity. The results, presented herein, indicate that the CD-CKF markedly outperforms existing continuous-discrete filters. [J752]

"Systemic approach explored in the context of passive target tracking"

For obvious reasons of cost, discretion and reliability costs, locating and tracking aerial targets under an electromagnetically completely passive paradigm, relying exclusively on illuminators of opportunity, is very appealing not only for military but also for civilian tasks. Such a passive radar system could exploit signals emitted by existing commercial television or radio stations or even satellite signals, such as the ones belonging to the global positioning system. This study considers target locating and tracking using a network of passive receivers and/or non-cooperative illuminators (a multi-static radar configuration) by making use of the Doppler shift only. A concept, the systemic approach, is used to combine and interpret information available from different sensors. Both the formalisation of the problem and the hardware and software implementation are presented. Implementation makes use of multi-component polynomial-phase signal models and genetic algorithms. For increased performance, implementation on field programmable gate array is envisaged. [J753]

"Algorithm for estimating co-polarised phase-difference using radiative transfer method and comparison with measurements"

A simple algorithm for estimating the co-polarised phase-difference of polarimetric radar backscatters from vegetated surfaces is proposed. The algorithm is verified by polarimetric scatterometer measurements of wetland rice fields at 5.3 GHz. It is also shown that the measured degrees of correlation of the rice fields are quite sensitive to incidence angle and the rice age. [J754]

"Scattering From Nonlinear Gravity Waves: The "Choppy Wave" Model"

To progress in the understanding of the impact of nonlinear wave profiles in scattering from sea surfaces, a nonlinear model for infinite-depth gravity waves is considered. This model, termed as the "Choppy Wave" Model (CWM), is based on horizontal deformation of a linear reference random surface. It is numerically efficient and enjoys explicit second-order statistics for height and slope, which makes it well adapted to a large family of scattering models. We incorporate the CWM into a Kirchhoff or small-slope approximation and derive statistical expressions for the corresponding incoherent cross section. We insist on the importance of "undressing" the wavenumber spectrum to generate a nonlinear surface with a prescribed spectrum. Interestingly, the inclusion of nonlinearities is found to be practically compensated by the spectral undressing process; an effect which might be specific to the CWM and needs to be investigated in the framework of fully nonlinear models. Accordingly, the difference between the respective normalized radar cross section is rather small. The most noticeable changes are faster azimuthal variations and a slight increase of the radar returns at nadir. A statistical analysis of sea clutter in the framework of a two-scale model is also performed at large but nongrazing incidence. It shows a pronounced polarization dependence of the distribution of large backscattered amplitudes, the tail being much larger in horizontal polarization and for small resolution cell. Surface nonlinearities are shown to increase the tail

of the amplitude distribution, as expected. Less obviously, their relative impact is found lesser in horizontal polarization. This raises the question of the actual contribution of nonlinearities in radar sea spikes at nongrazing angles. [J755]

"Method for non-stationary jammer suppression in noise radar systems"

Noise radars represent a rapidly growing research topic owing to numerous advantages over the conventional radars. This study proposes a method for strong non-stationary jammer suppression in noise radar systems. The corrupted received signal is divided into non-overlapping segments so that the instantaneous frequency (IF) of the jammer can be approximated by a parabola within each segment. To that end, an adaptive recursive procedure is proposed. The procedure uses the polynomial-phase transform to estimate the parabola coefficients. The jammer suppression is done for each segment separately. The simulations, performed for various types of FM interferences, prove the effectiveness of the proposed method even for highly non-stationary jammers with non-polynomial phase. [J756]

"A Virtual Antenna Beamforming (VAB) Approach for Radar Systems by Using Orthogonal Coding Waveforms"

An innovative approach is introduced to form virtual transmitting and receiving radar antenna beams simultaneously by transmitting orthogonal coding waveforms from the antenna elements and digitally processing of their echoes at the receiver. Multiple virtual transmitting-receiving beams can be formed simultaneously by employing an equal number of beamforming filters without increasing transmitting power or antenna gain or resolution loss. The virtually formed antenna beams can provide equivalent antenna gains and spatial resolutions as the conventional phased arrays of the same size. Because the actual antenna radiation pattern can be made almost isotropic, the new system has low probability of intercept (LPI) property. With both transmitting and receiving beams virtually implemented through digital filtering, costly radiation phase shift used in phased arrays is not needed for beam scanning in the proposed system. [J757]

"Estimation of Surface Roughness Parameter in Intertidal Mudflat Using Airborne Polarimetric SAR Data"

The coastal zones of the Korean peninsula are well known for their large tide ranges and vast expanse of intertidal flats. In this paper, methods of extracting the roughness of the scattering surface of intertidal mudflats from polarimetric synthetic aperture radar (SAR) data have been investigated. The L-band NASA/Jet Propulsion Laboratories airborne SAR data, which were acquired in the intertidal zone during PACRIM-II Korea campaign, were used to estimate the roughness of intertidal mudflats. Surface roughness can be utilized as a useful parameter to monitor the fishery activities in intertidal flats as well as the changes in textural characteristics of surface sediments. In order to retrieve roughness parameters, such as the rms height and the correlation length, of intertidal mudflats, three types of roughness inversion algorithms, based on the Integral Equation Method (IEM), semiempirical, and extended-Bragg models, have been investigated and developed. The inversion algorithms based on the IEM and semiempirical models can be applied to the dual-polarized SAR, while the extended-Bragg model-based inversion approach is also applicable to the fully polarimetric SAR observations. Results indicate the fully polarimetric approach is more pertinent to monitor geophysical parameters from space than the dual polarimetric approach, even if it is possible to reduce the number of unknown surface variables in the specific case of inversion problems. [J758]

"Polarization Symmetric Scatterer Metric Space"

The coherent polarization scattering matrix decomposition presented in Cameron et al. brought attention to the importance of Symmetric Scatterer Space, the space of scattering matrices corresponding to symmetric scatterers. Each symmetric scatterer scattering matrix can be associated with a complex number z, the scatterer-type parameter, where |z| les 1. A distance measure, d(z1, z2), was defined on Symmetric Scatterer Space providing a means of comparing scattering matrices. It will be demonstrated that Symmetric Scatterer Space is a metric space with metric d(z1, z2). A new mapping of the Unit Disc representation of Symmetric Scatterer Space to a sphere is also presented along with a metric on the sphere, ds(thetas1, phi1; thetas2, phi2), that is equivalent to the metric d(z1, z2) on the Unit Disc. [J759]

"Phenomenological Vessel Scattering Study Based on Simulated Inverse SAR Imagery"

This paper presents a study on the origin of the dominating scattering mechanisms observed in polarimetric synthetic aperture radar (SAR) images of ships. The study has been made by using numerical simulations, which have been carried out with a radar cross section (RCS) prediction tool (GRaphical Electromagnetic COmputing)

and a SAR simulator. Extensive series of simulations has been run for realistic 3-D geometrical models of ships with various sizes. Different radar parameters, aspect angles, and sea surface states have been considered in the scenario. Data analysis with coherent target decompositions has indicated characteristic polarimetric signatures for particular ships within a specific range of viewing angles. This happens at highly oblique incidences where the responses appear to be less sensitive to changes in the operating frequency and bearing angles. Under such conditions, ship scattering can be schematized by the distribution of a set of guide scatterers with high RCS. Their positions and polarimetric characteristics are quantitatively summarized in a new feature vector, which has been proposed to be the basis for classification algorithms. Key ideas about this vector are presented at the end of this paper, jointly with some examples related to three different ships. Recent publications have shown that they can be successfully cast within a new unsupervised vessel classification scheme. [J760]

"Windowed Fourier Transform for Noise Reduction of SAR Interferograms"

In this letter, since these methods are able to process signals locally, two spatial frequency analyses including windowed Fourier transform and wavelet transform are used to reduce synthetic aperture radar interferometric phase noise. [J761]

"Cloud and Rain Effects on AltiKa/SARAL Ka-Band Radar Altimeter-Part II: Definition of a Rain/Cloud Flag"

The main instrument of the French-Indian AltiKa/SARAL mission scheduled for launch in 2010 is the Ka-band AltiKa altimeter. The high attenuation due to atmospheric water (liquid or vapor) at this frequency band is the major drawback of the use of Ka-band. In part I of this paper, the impact of rain/clouds on Ka-band data and on the accuracy of the estimates of the geophysical parameters has been analyzed and quantified using an analytical model of waveform. Waveform distortion and errors on the geophysical parameters can be significant particularly for small dense clouds and rain cells. It is thus necessary to flag the data potentially affected by rain and clouds. The use of a single channel for AltiKa prevents the use of the classical dual-frequency rain flag used for Topex or Jason altimeters, and requires the definition of a new flag based on the altimeter signal alone. Past studies showed that clouds and rain are characterized by sharp coherent along-track fluctuations of the off-nadir angle estimates. The new flagging algorithm is based on the analysis of the variations of this parameter by the Matching Pursuit (MP) algorithm. MP allows the decomposition of a signal into a few salient features or atoms chosen from a dictionary of elementary functions. The dictionary is here defined by the wavelet decomposition of the signal. The method has been tested on an ensemble of AltiKa passes simulated for cloudy, rainy, and cloud/rain-free situations. The false alarm rate is almost nil while the detection performances are better than 90% at a range error of 5 cm and significant wave height error of 20 cm. The flag can easily be adapted to other altimeters' data and has been used to flag several Jason-1 passes. The comparison to the operational dual-frequency flag shows that the MP flag performs better in detecting range errors and waveforms distortion, while its performances are inferior in detecting samples attenuated by rain. [J762]

"On the Performance Limits of Cryogenically Operated SiGe HBTs and Its Relation to Scaling for Terahertz Speeds"

The goal of achieving terahertz (THz) transistors within the silicon material system has generated significant recent interest. In this paper, we use operating temperature as an effective way of gaining a better understanding of the performance limits of SiGe HBTs and their ultimate capabilities for achieving THz speeds. Different approaches for vertical profile scaling and reduction of parasitics are addressed, and three prototype fourth-generation SiGe HBTs are compared and evaluated down to deep cryogenic temperatures, using both dc and ac measurements. A record peak fT/fmaxof 463/618 GHz was achieved at 4.5 K using 130-nm lithography (309/343 GHz at 300 K), demonstrating the feasibility of reaching half-THz fTand fmaxsimultaneously in a silicon-based transistor. The BVCEOof this cooled SiGe HBT was 1.6 V at 4.5 K (BVCBO= 5.6 V), yielding a record fTtimes BVCEOproduct of 750 GHzldrV (510 GHzldrV at 300 K). These remarkable levels of transistor performance and the associated interesting device physics observed at cryogenic temperatures in these devices provide important insights into further device scaling for THz speeds at room temperature. It is predicted in a new scaling roadmap that fT/fmaxof room-temperature SiGe HBTs could potentially achieve 782/910 GHz at a BVCEOof 1.1 V at the 32-nm lithographic node. [J763]

"Cloud and Rain Effects on AltiKa/SARAL Ka-Band Radar Altimeter-Part I: Modeling and Mean Annual Data Availability"

The AltiKa project, developed by the French Centre National d'Etudes Spatiales, is based on a wideband Ka-band altimeter (35.75 GHz). The technical characteristic of the instrument will offer higher performance both in

terms of spatial and vertical resolutions that will lead to the improved observation of ice, coastal areas, inland waters, and wave height. An Indian Space Research Organization satellite, called Satellite with ARgos and AltiKa, will embark the AltiKa altimeter. The launch is scheduled at the end of 2010. The major drawback of Ka-band use is the attenuation of the radar signal by atmospheric liquid water. Clouds and rain effects will thus be a strong constraining factor, because the altimeter link budget imposes an attenuation of less than 3 dB. The impact of rain and clouds on Ka-band altimeter data is analyzed and quantified using an analytical model that computes AltiKa waveforms in the presence of rain or clouds. The results are then used to quantify the waveform attenuation and distortion, as well as the error induced on the altimeter geophysical parameter estimates. Because of the nonlinearity of attenuation relations, the impact of clouds/rain depends more on the cloud/rain variability within the altimeter footprint than on the mean characteristics, which makes correction using coincident rain or cloud data difficult. Small rain cell and small dense clouds can thus strongly distort the waveforms and lead to erroneous geophysical parameter estimates. The probability of 20 Hz and 1-s averaged data loss are computed from the model results and from cloud and rain climatologies. On a global scale, about 3.5% of the 20-Hz data will be lost because of rain and clouds and 2.5% of the 1-s averaged data. However, the probability strongly varies over the global ocean and can exceed 10% in the Tropics. [J764]

"CTBV Integrated Impulse Radio Design for Biomedical Applications"

Improving quality of service in wireless communication links is of vital importance in biomedical applications. Limitations of current technology are evident with a limited number of channels and prone to fading. In this paper, we are exploring impulse radio as a feasible technology for health monitoring and even as novel detached sensors. By exploring advanced deep submicron technology and novel architectures, improved quality of service may be granted. Additional interesting biomedical functionality of the impulse radio is detached body sensors (short-range medical radar). [J765]

"Spherical Cap Adaptive Antennas for GPS"

The capability of non-planar adaptive antennas for suppressing interference in GPS applications is addressed. An optimization problem based on power minimization of incident signals is formulated, resulting in a solution that maximizes the signal-to-interference-plus-noise ratio at the output of the antenna array and subsequently the carrier-to-noise-ratio of a GPS satellite signal. Spherical adaptations of a planar seven element controlled reception pattern antenna array are presented for various low-horizon interference environments. [J766]

"Efficient Directional Gaussian Smoothers"

Linear and nonlinear filters, including morphological operators, play a significant role in the processing of remote sensing imagery. In particular, smoothing filters have been extensively used for noise removal and image restoration. In applications where linear and shift-invariant filters can be effectively employed, filtering is computationally efficient if implemented in transform domains. Nevertheless, in remote sensing applications, it is essential that smoothing filters be capable of handling missing and erroneous data without loss of information. In such cases, filtering requires the involvement of logical operations in order to determine which pixels should be used for processing, and thus takes the form of a nonlinear operator. Hence, transform-based methods cannot be used. Still, in applications where large volumes of data need to be processed, it is greatly desired that fast filtering algorithms are used. This letter introduces a computationally efficient spatial-domain-based implementation which is partially separable and steerable. The technique is general, and its efficiency has been demonstrated on weather radar data. It is shown that the proposed filtering approach is significantly faster compared to a recently introduced separable filter implementation. [J767]

"Laser Radar Receiver Channel With Timing Detector Based on Front End Unipolar-to-Bipolar Pulse Shaping"

An integrated receiver channel for a pulsed time-of-flight laser range finder is presented based on a timing discrimination principle in which the incoming unipolar detector current pulse is converted to a bipolar pulse at the front end of the receiver channel. Thus no optical or electrical gain control is needed within the dynamic range of the receiver, which according to measurements is 1:3000 with a timing walk error of plusmn 55 ps (plusmn 8 mm in distance). The minimum detectable input signal current is about 1.3 muA at an SNR of 10 with a bandwidth of 200 MHz. The circuit is realized in a 0.35 mum SiGe BiCMOS process and consumes 220 mW of power. [J768]

"One- and Two-Stage Tunable Receivers"

In this paper, we propose and assess a CFAR detector that can adjust its ldquodirectivityrdquo through a real scalar parameter. It relies on the usual assumption that a set of homogeneous training data is available and

encompasses as special cases the well-known Kelly's GLRT and the recently introduced W-ABORT detector. More important, it can be tuned in order to control the level to which sidelobe signals are rejected. Such functionality is particularly important to contain the number of false alarms in presence of mismatched signals. We also consider a parametric detector which resorts to a diagonally loaded sample covariance matrix commonly adopted to take advantage of the presence of strong interferers. The performance assessment of such detector has shown that it can significantly outperform Kelly's GLRT in terms of prediction probabilities for matched signals and in terms of selectivity, but it is not strictly CFAR. We also propose to use the CFAR parametric detector as second stage of a two-stage tunable detector and show that such a two-stage detector can outperform already proposed tunable receivers in terms of selectivity. The analysis of the detectors is conducted assuming a homogeneous Gaussian environment; with reference to this scenario and to the CFAR detectors we derive analytical expressions for the probability of false alarm and the probability of detection for both matched and mismatched signals. [J769]

"A Compressive Sensing Data Acquisition and Imaging Method for Stepped Frequency GPRs"

A novel data acquisition and imaging method is presented for stepped-frequency continuous-wave ground penetrating radars (SFCW GPRs). It is shown that if the target space is sparse, i.e., a small number of point like targets, it is enough to make measurements at only a small number of random frequencies to construct an image of the target space by solving a convex optimization problem which enforces sparsity through lscr1minimization. This measurement strategy greatly reduces the data acquisition time at the expense of higher computational costs. Imaging results for both simulated and experimental GPR data exhibit less clutter than the standard migration methods and are robust to noise and random spatial sampling. The images also have increased resolution where closely spaced targets that cannot be resolved by the standard migration methods can be resolved by the proposed method. [J770]

"Statistical Characteristics of the Global Surface Current Speeds Obtained From Satellite Altimetry and Scatterometer Data"

Near-real time ocean surface currents derived from satellite altimeter (JASON-1, GFO, ENVISAT) and scatterometer (QSCAT) data on 1deg times 1deg resolution for world oceans (60deg S to 60deg N) are available online as ldquoOcean Surface Current Analyses-Real Time (OSCAR).rdquo The probability distribution function (PDF) of the current speeds (omega), constructed from global OSCAR data from 1992 to 2008, satisfies the two-parameter Weibull distribution reasonably well, and such a PDF has little seasonal and interannual variations. Knowledge on PDF of omega will improve the ensemble horizontal flux calculation, which contributes to the climate studies. [J771]

"Efficient Wideband Parameter Estimation Using Arbitrary Enveloped LFM Signals via Hermite Decompositions"

Signals with finite time support are frequently used in active sonar and radar processing. In these applications, for efficient computations, it is necessary to have a compact description of the signals' shape and time evolution. For this purpose, the Hermite series expansions are used in this paper to approximate an arbitrary enveloped linear frequency modulated signal. The Hermite basis functions are based on the product of Hermite polynomials and a Gaussian function. The analytical expressions for the Fourier transform of linear frequency modulated (LFM) Hermite functions are presented. It is proposed to use the Fourier transform of LFM Hermite functions for efficient computation of the wideband cross-ambiguity function (WCAF) for target parameter estimation in active sonar processing. Efficient 2-D search methods are also proposed to obtain parameters from the WCAF. [J772]

"Measurements of Dielectric Constant of Volcanic Ash Erupted From Five Volcanoes in Japan"

The dielectric properties of volcanic ash from five volcanoes in Japan were measured by using the transmission/reflection coaxial line method of a network analyzer, in a frequency range from 3 to 13 GHz. The measured permittivity of powdered ash was then converted to that of solid ash (dense rock equivalent) with the aid of effective medium theory. The values of solid-ash relative permittivities for the five volcanoes revealed that they were in a relatively narrow range. Their real part was generally in a range from five to six in magnitude, while their imaginary part was in a range from 0.08 to 0.18. [J773]

"History and Applications of UWB"

This mathematical modeling method for wireless networks is designed to take into account propagation effects and interference from unwanted transmissions. [J774]

"Improved design of DFCW for MIMO radar"

The successful design of a discrete frequency-coding waveform for MIMO radar which can achieve a lower range autocorrelation sidelobe peak and range cross-correlation peak is presented. The numerical results are presented to verify the effectiveness of this method. [J775]

"Target Detection in SAR Images Based on a Level Set Approach"

This paper introduces a new framework for point target detection in synthetic aperture radar (SAR) images. We focus on the task of locating reflective small regions using a level-set-based algorithm. Unlike most of the approaches in image segmentation, we address an algorithm that incorporates speckle statistics instead of empirical parameters and also discards speckle filtering. The curve evolves according to speckle statistics, initially propagating with a maximum upward velocity in homogeneous areas. Our approach is validated by a series of tests on synthetic and real SAR images and compared with three other segmentation algorithms, demonstrating that it configures a novel and efficient method for target-detection purpose. [J776]

"Pulse-Based Radar Imaging Using a Genetic Optimization Approach for Echo Separation"

This paper describes a novel 3-D ultra-wideband (UWB) imaging technique with the aim of detecting, classifying, and imaging water pipes located inside walls. The target under test was chosen in such a way that the echoes of the front side of the wall and of the water pipes overlap making it impossible to distinguish between them in the raw data. Applying a genetic optimization algorithm for modeling the radar response by a superposition of single echoes it was possible to determine the exact round-trip times of several scatterers. Moreover, the algorithm takes into account the pulse distortion caused by varying angles of incidence at the broad beam antenna. [J777]

"Bathymetric Retrieval From Hyperspectral Imagery Using Manifold Coordinate Representations"

In this paper, we examine the accuracy of manifold coordinate representations as a reduced representation of a hyperspectral imagery (HSI) lookup table (LUT) for bathymetry retrieval. We also explore on a more limited basis the potential for using these coordinates for modeling other in water properties. Manifold coordinates are chosen because they are a data-driven intrinsic set of coordinates, which naturally parameterize nonlinearities that are present in HSI of water scenes. The approach is based on the extraction of a reduced dimensionality representation in manifold coordinates of a sufficiently large representative set of HSI. The manifold coordinates are derived from a scalable version of the isometric mapping algorithm. In the present and in our earlier works, these coordinates were used to establish an interpolating LUT for bathymetric retrieval by associating the representative data with ground truth data, in this case from a Light Detection and Ranging (LIDAR) estimate in the representative area. While not the focus of the present paper, the compression of LUTs could also be applied, in principle, to LUTs generated by forward radiative transfer models, and some preliminary work in this regard confirms the potential utility for this application. In this paper, we analyze the approach using data acquired by the Portable Hyperspectral Imager for Low-Light Spectroscopy (PHILLS) hyperspectral camera over the Indian River Lagoon, Florida, in 2004. Within a few months of the PHILLS overflights, Scanning Hydrographic Operational Airborne LIDAR Survey LIDAR data were obtained for a portion of this study area, principally covering the beach zone and, in some instances, portions of contiguous river channels. Results demonstrate that significant compression of the LUTs is possible with little loss in retrieval accuracy. [J778]

"Joint time difference of arrival/angle of arrival position finding in passive radar"

Several target position finding methods are proposed in various papers mainly regarding sensor networks. However, the problem of position finding in passive radar systems is somewhat different from the general case of sensor networks. Generally, in a passive radar system, there are few receivers located at short distances when compared with the it distance from the target. In this case, a problem known as geometric dilution of precision (GDP) occurs, which considerably increases the error of many proposed methods. This phenomenon can even make the position finding equations non-solvable. Regarding this fact, we have developed a least mean square error (LMSE) based method, which uses both the angle of arrival (AOA) and time difference of arrival (TDOA) measurements to estimate almost precisely the position of very distant targets in a passive radar system. A simple equation is derived here to compare the TDOA and AOA accuracies. Then, it is shown that whenever the accuracies of these two measurements are comparable, the proposed method estimates the target position more precisely than the conventional AOA-only and TDOA-only methods. It also avoids the non-convergence behaviour encountered in TDOA-only methods. [J779]

"Novel joint time delay and frequency estimation method"

A novel algorithm has been proposed for joint time delay and frequency estimation of sinusoidal signals received

at multiple separated sensors. The joint time delay and frequency estimation problem is linked to a trilinear model. Exploiting this link, it derives a trilinear decomposition-based joint time delay and frequency method algorithm. The simulation results reveal that the algorithm performance is close to that of the Cramer-Rao lower bound, and the proposed algorithm even supports small sample sizes. [J780]

"Two-Dimensional Spectrum Matched Filter Banks for High-Speed Spinning-Target Three-Dimensional ISAR Imaging"

In this letter, a 3-D inversed synthetic aperture radar imaging algorithm for targets in high-speed spinning is proposed based on 2-D spectrum matched filter (MF) banks. Each spectrum MF bank yields a focused slice for its corresponding scatterers. By extracting the spatial parameters from all slices, the 3-D image of the target can be constructed. Numeric simulation confirms the validity of the algorithm. [J781]

"Network-based mobility management in the evolved 3GPP core network"

A key aspect of the 3GPP system architecture evolution is the specification of an evolved packet core that supports multiple access networks. The EPC enables operators to deploy and operate one common packet core network for 3GPP radio accesses (E-UTRAN, UTRAN, and GERAN), as well as other wireless and wireline access networks (e.g., eHRPD, WLAN, WIMAX, and DSL/Cable), providing the operator with a common set of services and capabilities across the networks. A key requirement of the EPC is to provide seamless mobility at the IP layer as the user moves within and between accesses. This article provides an overview of the EPC specifications that use a network-based mobility mechanism based on Proxy Mobile IPv6 to enable mobility between access networks. An important facet of providing seamless mobility for a user's sessions across technologies is to ensure that quality of service is maintained as the user moves between accesses. An overview of the "off-path" QoS model to supplement PMIPv6 is also provided. [J782]

"Near Real-Time Orthorectification and Mosaic of Small UAV Video Flow for Time-Critical Event Response"

A method for real-time mosaic of video flow acquired by a small low-cost unmanned aerial vehicle (UAV) has been presented in this paper. The basic procedures of real-time mosaic are as follows: (1) Each video frame is resampled and orthorectified using a developed mathematical model, which can simultaneously solve the video camera's interior orientation parameters and the exterior orientation parameters of each video frame; (2) each orthorectified video frame is mosaicked at real time. A test field located in Picayune, Mississippi, has been established for testing our method. Sixty-minute video data were collected using the UAV and were processed using the proposed method. The results demonstrated that each video frame can be geo-orthorectified and mosaicked together to produce a 2-D planimetric mapping at near real time. Accuracy of the mosaicked video images (2-D planimetric map) is approximately 1-2 pixels, when compared to 55 checkpoints, which were measured by differential GPS surveying. [J783]

"Microwave Photonics"

Broadband and low loss capability of photonics has led to an ever-increasing interest in its use for the generation, processing, control and distribution of microwave and millimeter-wave signals for applications such as broadband wireless access networks, sensor networks, radar, satellite communitarians, instrumentation and warfare systems. In this tutorial, techniques developed in the last few years in microwave photonics are reviewed with an emphasis on the systems architectures for photonic generation and processing of microwave signals, photonic true-time delay beamforming, radio-over-fiber systems, and photonic analog-to-digital conversion. Challenges in system implementation for practical applications and new areas of research in microwave photonics are also discussed. [J784]

"Voice call handover mechanisms in next-generation 3GPP systems"

The evolved 3GPP system is a hybrid mobile network architecture supporting several radio access technologies and several mobility mechanisms. In this article we briefly review the architecture and key components of this system, with particular emphasis on how it can support voice call mobility in several deployment scenarios. First, we present the so-called single-radio voice call continuity mechanisms that enable mid-call handover of VoIP calls from E-UTRAN access to the legacy UTRAN/GERAN or lxRTT access. Then we focus on deployment scenarios that do not support voice services on E-UTRAN and present the so-called fallback mechanisms that enable handover from E-UTRAN to UTRAN/GERAN or lxRTT at the beginning of a voice call. Finally, we address the application- layer voice call handover mechanisms enabled by the IP multimedia subsystem. Our conclusion is that the next generation of 3GPP systems are highly sophisticated mobile communication systems

that support extended voice call mobility mechanisms, capable of addressing all commercial deployment needs. [J785]

"A Study of UWB FM-CW Radar for the Detection of Human Beings in Motion Inside a Building"

A study of an ultrawideband frequency-modulated continuous-wave radar with an extended frequency sweep from 0.5 to 8 GHz is presented. It has been applied to through-the-wall human detection. This work presents the modeling of wall attenuation followed by real measurements. The radar system is presented, and trials of human being tracking are shown. This radar will enable large stand-off distance capabilities and dasiadasiain-depthpsilapsila building detection. [J786]

"Characterizing L-Band Scattering of Paddy Rice in Southeast China With Radiative Transfer Model and Multitemporal ALOS/PALSAR Imagery"

Rice is a major food supply in southeast China. With increased population and urbanization, reliable rice mapping is critical in this region. Because of frequent cloud cover and precipitation during the rice-growing season, it is difficult to conduct large-area rice monitoring with optical remote sensing techniques. L-band synthetic aperture radar (SAR), with its all-weather day and night imaging and canopy penetration capabilities, provides a unique alternative. In this study, a first-order radiative transfer model was developed to simulate L-band scattering properties of paddy rice. Three Advanced Land Observing Satellite (ALOS)/Phased-Array-Type L-band Synthetic Aperture Radar (PALSAR) images in dual-polarization mode (HH and HV) acquired in early tillering (June 28, 2007), tillering (August 13, 2007), and heading (September 28, 2007) stages were processed to test the temporal variation of rice backscatter. It was found that plant height and leaf mass amount were the two major structural parameters that contributed to rice backscatter in PALSAR images. The variation of the simulated HH backscatter matched with PALSAR observations in sample fields, although the simulated backscatter coefficients were around 3 dB lower than image-extracted values. Leaf volume scattering and leaf-ground double bounce were found as the two major scattering components in L-band HH polarization and increased with leaf layer height and density. This paper demonstrated that L-band HH backscatter was more sensitive to rice's structural variation than the VV backscatter and may therefore be more useful in rice mapping and modeling studies. [J787]

"MCA: A Multichannel Approach to SAR Autofocus"

We present a new noniterative approach to synthetic aperture radar (SAR) autofocus, termed the multichannel autofocus (MCA) algorithm. The key in the approach is to exploit the multichannel redundancy of the defocusing operation to create a linear subspace, where the unknown perfectly focused image resides, expressed in terms of a known basis formed from the given defocused image. A unique solution for the perfectly focused image is then directly determined through a linear algebraic formulation by invoking an additional image support condition. The MCA approach is found to be computationally efficient and robust and does not require prior assumptions about the SAR scene used in existing methods. In addition, the vector-space formulation of MCA allows sharpness metric optimization to be easily incorporated within the restoration framework as a regularization term. We present experimental results characterizing the performance of MCA in comparison with conventional autofocus methods and discuss the practical implementation of the technique. [J788]

"Empirically Adopted IEM for Retrieval of Soil Moisture From Radar Backscattering Coefficients"

The integral equation model (IEM) is considered as a promising algorithm for soil moisture retrieval from active microwave data over bare soil and sparsely vegetated conditions. However, the soil dielectric constant is implicitly embedded in the complicated IEM; inversion of soil moisture is often accomplished through iteration and is thus computationally expensive, particularly when it is applied to retrieve soil moisture from active microwave data on a large scale. To simplify the inversion process of soil moisture directly from the active microwave data, basic math functions were adopted to fit the simulation results of the original IEM so that the radar backscattering coefficient becomes an explicit function of soil dielectric constant or the soil dielectric constant is an explicit function of radar backscattering coefficient. Soil moisture is then calculated directly from radar backscattering coefficient without iteration. We called this model empirically adopted IEM (EA-IEM). The accuracy of the EA-IEM to the original IEM and its applicability are analyzed through three processes: model intercomparison, sensitivity analysis, and model comparison with insitumeasurements. The average differences of backscattering coefficients between the EA-IEM and the original IEM are 0.14 dB for HH-polarization and 0.12 dB (Gaussian correlation function) and 0.2 dB (exponential correlation function) for VV-polarization. The sensitivity of soil moisture variation is examined under the consideration of absolute and relative calibration errors. A comparison between the soil moisture estimated and the measurements is performed, and the root-mean-square (rms) error is found to be 3.4%, suggesting that the EA-IEM performs well in these real cases. All

these analyses indicate that the EA-IEM is a good representative of the original IEM and can be used to retrieve soil moisture under the tested range of model parameters: incidence angles between 10degand 60--deg, soil dielectric constants between 4 and 42, surface rms height from 4 to 31 mm, and correlation length from 50 to 250 mm. [J789]

"Polarimetric Dual-Baseline InSAR Building Height Estimation at L-Band"

This letter generalizes a multibaseline interferometric synthetic aperture radar (InSAR) signal model to the polarimetric scenario. Based on this formulation, two high-performance spectral analysis techniques are adapted to process multibaseline Pol-InSAR observations. These new methods enhance the height estimation of scatterers by calculating optimal polarization combinations and allow the determination of their physical characteristics. Applying the proposed algorithms to urban environments, the building layover problem is analyzed by means of polarimetric dual-baseline InSAR measurements: the ground and building height are estimated. The techniques are validated using dual-baseline Pol-InSAR data acquired by DLR's Experimental SAR (E-SAR) system over Dresden city. [J790]

"Through-the-Wall Imaging Using Differential SAR"

An algorithm for imaging of targets behind walls is proposed to reduce the wall reflection and enhance the signal-to-clutter ratio. The image formation is based on differential synthetic-aperture-radar image formation employing a continuous-wave radar system. In this approach, instead of using individual backscattered signals, the image is formed by employing the difference signals obtained by subtracting two successive signals along the track. This way, specular reflections are totally eliminated without the need for the knowledge of the wall parameters. This also affects the point target response which is corrected by an integration process. By using backscattered fields from small trihedral corner reflectors behind a poured concrete wall, measured over a frequency band of 1-2.5 GHz, the proposed method is demonstrated. [J791]

"Bat Chirps With Good Properties: Zak Space Construction of Perfect Polyphase Sequences"

Previously, a discretization of the linear FM chirp of length N=KL2, Land KLisin Z, was given and the conditions for its minimal Zak space support were derived. Chirps satisfying these conditions are known as finite chirps. In this work, subsets of finite chirps of length N=L2, La prime, are examined. The investigation leads to a new, Zak space construction of general polyphase sequence sets of size L-1 with optimal auto and cross-correlation properties, known as perfect sequence sets. It is shown that perfect sequence sets are closely related to sets of finite chirps and, in particular, include the sets of Zadoff-Chu sequences (which are identical with subsets of finite chirps) and the sets of generalized Frank sequences (which are identical with sets of modulations of finite chirps), as special cases. The entire collection of perfect sequence sets is then given by a partition of the set of perfect auto correlation sequences, obtained by right coset decomposition of the group of all permutations with respect to a certain cyclic group. The construction suggests several further generalizations that can be obtained by operating exclusively on subgroups of the permutation group. [J792]

"Human Activity Classification Based on Micro-Doppler Signatures Using a Support Vector Machine"

The feasibility of classifying different human activities based on micro-Doppler signatures is investigated. Measured data of 12 human subjects performing seven different activities are collected using a Doppler radar. The seven activities include running, walking, walking while holding a stick, crawling, boxing while moving forward, boxing while standing in place, and sitting still. Six features are extracted from the Doppler spectrogram. A support vector machine (SVM) is then trained using the measurement features to classify the activities. A multiclass classification is implemented using a decision-tree structure. Optimal parameters for the SVM are found through a fourfold cross-validation. The resulting classification accuracy is found to be more than 90%. The potentials of classifying human activities over extended time duration, through wall, and at oblique angles with respect to the radar are also investigated and discussed. [J793]

"Spaceborne Spotlight SAR Interferometry With TerraSAR-X"

Recently, synthetic aperture radar (SAR) data with 1-m resolution acquired by satellites in spotlight mode became available to the public. In this paper, we elucidate the differences between interferometric processing of strip map and of spotlight SAR data, and we outline adequate algorithms for key processing steps such as azimuth Doppler filtering. We further present first TerraSAR-X spotlight interferograms, together with an evaluation of the paraeters that are critical for interferometry. Our results indicate a very good geometric accuracy, stability, and phase fidelity of the TerraSAR-X sensor and its products. From the interferograms, we are able to determine the heights of larger buildings and millimeter-scale structural deformation in several

examples. The high detail level of imaged buildings and the good temporal phase coherence of urban areas in X-band make spotlight interferometry an exciting processing technique that enables new applications such as surveying individual buildings. [J794]

"A Class of Zero-Correlation Zone Sequence Set Using a Perfect Sequence"

This letter introduces a novel method of sequence construction having a zero-correlation zone. The cross-correlation function and the side-lobe of the auto-correlation function of the proposed sequence set is zero for the phase shifts within the zero-correlation zone. The proposed zero-correlation zone sequence set can be generated from an arbitrary perfect ternary sequence, the length of which is the product of a pair of odd integers ((2k+1)(2n+1) for kges 1 and nges 0). The width of the zero-correlation zone of the proposed sequence set can be longer than the length of the perfect sequence that is used for constructing the proposed sequence set. The proposed sequence construction can generate an optimal zero-correlation zone sequence set that satisfies the theoretical bound of the sequence member size for the zero-correlation zone and the sequence period. [J795]

"Adaptive Algorithms to Track the PARAFAC Decomposition of a Third-Order Tensor"

The PARAFAC decomposition of a higher-order tensor is a powerful multilinear algebra tool that becomes more and more popular in a number of disciplines. Existing PARAFAC algorithms are computationally demanding and operate in batch mode-both serious drawbacks for on-line applications. When the data are serially acquired, or the underlying model changes with time, adaptive PARAFAC algorithms that can track the sought decomposition at low complexity would be highly desirable. This is a challenging task that has not been addressed in the literature, and the topic of this paper. Given an estimate of the PARAFAC decomposition of a tensor at instant t, we propose two adaptive algorithms to update the decomposition at instant t+1, the new tensor being obtained from the old one after appending a new slice in the 'time' dimension. The proposed algorithms can yield estimation performance that is very close to that obtained via repeated application of state-of-art batch algorithms, at orders of magnitude lower complexity. The effectiveness of the proposed algorithms is illustrated using a MIMO radar application (tracking of directions of arrival and directions of departure) as an example. [J796]

"Model-Based Compensation of Topographic Effects for Improved Stem-Volume Retrieval From CARABAS-II VHF-Band SAR Images"

A limiting factor that has been identified for stem-volume retrieval in coniferous forests using VHF synthetic aperture radar is that the backscatter varies depending on ground topography. On sloping ground, the backscatter from a forest is reduced, since the dominant ground-trunk double-bounce scattering mechanism is changed. This leads to underestimation of stem volume, and the variations caused by topography can obscure real variations in stem volume. By using multiple images acquired with different flight headings and combining the image information with ground-topography data in a model-based inversion method, we are able to compensate for the ground-topography influence on the backscatter. The inversion method is based on image segmentation and the optimal estimation method. Using four or more images from the CARABAS-II system and a coarse digital elevation model with 50-m horizontal grid, the stem volume can be retrieved with an average root-mean-square error (rmse) of less than 60 m3ha-1for stem volumes in range of 80-700 m3ha-1(in terms of above-ground biomass, this is equivalent to an rmse of less than 40 ton ldr ha-1over the range of 50-400 ton ldr ha-1). The retrieval accuracy is similar to that previously obtained for similar forests standing on flat and horizontal ground. [J797]

"Code-Division Multiple Transmission for High-Speed UWB Radar Imaging With an Antenna Array"

The ultrawideband (UWB) radar is a promising high-resolution 3-D imaging technique for near targets. We have developed a high-speed imaging algorithm, SEABED, for a UWB pulse radar, a key real-time imaging technology. When the algorithm is applied to UWB, antenna scanning for data acquisition takes significantly longer than calculating the SEABED algorithm itself. This presents a serious problem for the real-time application of UWB radar. In this paper, we use pseudonoise (PN) sequences as the transmitting waveforms, while the original work on the SEABED algorithm assumed impulsive short-wave pulses. Using PN sequences enables us to simultaneously transmit signals with multiple antennas, eliminating the need to scan antennas. We demonstrate that the proposed radar system works well using random sequences to suppress direct waves, which is critical in achieving high speeds for imaging. [J798]

"The Canberra high altitude mission platform"

This presents the capabilities of two English Electric Aviation Canberra aircraft owned by High Altitude Mapping

Missions, Inc. These aircraft are available for high altitude commercial, government, and scientific missions. The basic specifications of the Canberra are provided and compared to other high-performance jet aircraft falling into the same category. This describes the high altitude flight characteristics and mission capabilities of the Canberras. The aircraft are configured to conduct up to eight-hour flight operations with up to six hours at 50,000 feet altitude. Shorter missions can be conducted at higher altitudes. Potential missions include: IFSAR, magnetic field mapping, gravity field mapping, imaging (SAR, IR, & hyper-spectral), LIDAR, communications relay, dropsonde deployment, hybrid rocket launching, severe storm monitoring, and disaster monitoring. Canberra high altitude operations have minimal weather impact on missions, are free from flight constraints imposed by air traffic control, can do large area coverage, and long mission times. [J799]

"An Efficient Method for Performance Monitoring of Active Phased Array Antennas"

Modern synthetic aperture radars (SARs) are equipped with active phased array antennas to electronically generate various antenna beams. The TerraSAR-X satellite is a high resolution SAR system launched in June 2007. Its active phased array X-band antenna hosts 384 transmit/receive modules (TRMs) for controlling the electronic beam steering in azimuth and elevation direction. The precise modeling of the antenna performance is only possible if the actual characteristics of each individual TRM are monitored. TerraSAR-X has been equipped with an innovative characterization mode based on a coding technique, which is the so-called pseudonoise gating method. The individual and simultaneous characterization of all TRMs is realized under most realistic conditions with power supply loads like in nominal radar operation. For the first time, this novel technique has been applied on a spaceborne SAR system. [J800]

"A Fast and Accurate Far-Field Pseudopolar Format Radar Imaging Algorithm"

A novel imaging algorithm to be used under the condition of having an image scene in the far field of a linear radar aperture is presented. This is an application scenario that is drastically different from those of spaceborne and airborne synthetic aperture radar (SAR) systems, which has not been properly addressed to date. The technique is particularly tailored for a stepped-frequency continuous wave (CW) or frequency-modulated CW radar. The radar aperture must be linear and can be formed either with a physical or synthetic array. With the suggested method, the radar reflectivity of the image scene is obtained through an interpolation-free series expansion, where only 2-D fast Fourier transforms of the frequency-domain backscatter data are required. The resulting image is sampled on a ldquopolarlikerdquo or pseudopolar grid, which is introduced to simplify the formulation. The main advantages of this method are its extremely low computational cost and the high accuracy of the resulting imagery. The technique is extensively validated both with numerical simulations and two ground-based SAR data sets. Last but not least, numerical simulations show that this technique can be used with an ultrawideband radar of 1 GHz of bandwidth. [J801]

"Static Security Optimization for Real-Time Systems"

An increasing number of real-time applications like railway signaling control systems and medical electronics systems require high quality of security to assure confidentiality and integrity of information. Therefore, it is desirable and essential to fulfill security requirements in security-critical real-time systems. This paper addresses the issue of optimizing quality of security in real-time systems. To meet the needs of a wide variety of security requirements imposed by real-time systems, a group-based security service model is used in which the security services are partitioned into several groups depending on security types. While services within the same security group provide the identical type of security service, the services in the group can achieve different quality of security. Security services from a number of groups can be combined to deliver better quality of security. In this study, we seamlessly integrate the group-based security model with a traditional real-time scheduling algorithm, namely earliest deadline first (EDF). Moreover, we design and develop a security-aware EDF schedulability test. Given a set of real-time tasks with chosen security services, our scheduling scheme aims at optimizing the combined security value of the selected services while guaranteeing the schedulability of the real-time tasks. We study two approaches to solve the security-aware optimization problem. Experimental results show that the combined security values are substantially higher than those achieved by alternatives for real-time tasks without violating real-time constraints. [J802]

"Exploitation of Ship Scattering in Polarimetric SAR for an Improved Classification Under High Clutter Conditions"

This paper evaluates the potentialities of polarimetric ship scattering for basing classification methods that provide reasonable performance within cluttered scenes. Both simulated and airborne polarimetric synthetic aperture radar (SAR) images have been used to validate the conclusions of a previous phenomenological study. Numerical simulations have been carried out with GRECOSAR, a polarimetric interferometric SAR simulation tool

that is able to process highly complex targets with a fast and accurate radar-cross-section prediction module. A representative set of scenarios has been defined, which includes various realistic ship models, sea states, and imaging geometries. In all of them, a two-scale sea surface model precisely accounting for sea-ship interaction and sea clutter has been added. The analysis of different images has shown that, with an adequate spatial resolution, ships may be characterized by a particular spatial arrangement and polarization state distribution of dominant scattering centers. This feature has allowed one to propose a new classification algorithm, which shows a promising behavior after various preliminary tests. In this paper, the performance of this technique is further evaluated with realistic clutter. The results show that robust classification is possible even in highly cluttered scenes if quad-pol imagery is available. On the contrary, in low clutter conditions, the usage of less restrictive solutions, like circular dual-pol schemes, is feasible and may still get an acceptable performance. [J803]

"Estimation of Sahelian-Grassland Parameters Using a Coherent Scattering Model and a Genetic Algorithm"

In this paper, the applicability of a procedure for retrieval of vegetation parameters using a coherent scattering model that considers the botanical properties of Sahelian grassland and a stochastic optimization algorithm is studied. This African vegetation is mainly composed of shrubs and grass. Since the coherent scattering model is computationally time-consuming, a simplified empirical model is constructed by fitting of simulation results obtained by the scattering model. Inputs to the empirical model are the sensitive parameters that, for the studied class of vegetation, are the soil moisture content, grass density, and grass moisture content. The model outputs are the polarimetric backscattering coefficients as a function of the incidence angle. Employing the empirical model and a genetic algorithm, a search routine is implemented to estimate the biophysical parameters of the African vegetation from a data set of backscattering coefficients. The estimation of Sahelian-grassland parameters using the set of C-band HH-polarized measured data shows that this procedure achieves good agreement with the ground-truth data. [J804]

"Sea Surface Manifestation of Along-Tidal-Channel Underwater Ridges Imaged by SAR"

A group of submerged ocean bottom sand ridges in the Bohai Sea, China, are shown in RADARSAT-1 and ENVISAT synthetic aperture radar (SAR) images. The sand ridges appear as fingerlike quasi-linear features in the SAR images. Examining the detailed local bathymetry chart, we find that these features coincide with the satellite images. The heights of the sand ridges are less than 10 m, and the water depth is between 10 and 30 m. The spacing of the sand ridges is about 10 km, and the length of the sand ridges is about 20 km. The same sand ridges are also visible on a Moderate Resolution Imaging Spectroradiometer (MODIS) true-color image. The semidiurnal and diurnal tidal currents in this area are almost parallel to the major axis of these sand ridges. These observations cannot be explained using the existing 1-D SAR imaging model, which is not applicable to sand ridges parallel to the tidal current. In this paper, we consider the shallow-water current bathymetry in a 2-D space. An analytical ocean model was applied to demonstrate the temporal variations of the current divergence and convergence that are induced by the along-sand-ridge-direction current and ridge interaction. A radar simulation model is used to simulate the variation of normalized radar cross section (NRCS) induced by the ocean surface current. The simulated NRCS variation is similar to that extracted from the calibrated SAR image. Simulation results also show that the NRCS variation becomes negligible when the ocean current is set to about half of the maximum tidal current. [J805]

"Assessment of Glacier Volume Change Using ASTER-Based Surface Matching of Historical Photography"

Glaciated regions are known to be particularly sensitive to climate change. Historical archives of glacier volume change are important, as they provide context for present-day changes. Although photogrammetric archives exist for many regions, their usefulness is often limited by a lack of contemporary ground control. High quality digital elevation models (DEMs) underpin a range of change analysis activities. This paper presents a cost-effective solution which utilizes Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) DEMs as control for the scaling and orientation of archival data sets. Instead of relying upon ground-control points, a robust surface matching algorithm is employed to automatically determine the transformation required to register two overlapping DEMs. Through application to the Slakbreen glacier system in Svalbard, Norway, the strategy is assessed by first matching an ASTER DEM to a fixed lidar reference surface. This demonstrates that ASTER DEMs are effectively correct in scale, supporting their use as a control surface. The second stage of the research implements this by matching an aerial photogrammetric DEM to an ASTER reference surface. Resultant volumetric and annual elevation change rates are compared to those derived from lidar data, which are considered in this paper as a truth data set. ASTER-based matching produced a mean annual elevation change rate of -4.12 ma-1, compared to a value of -4.11 ma-1derived from the lidar data. In volumetric terms, this

equates to a difference of 0.6%. A major advantage of this approach is the near-global coverage offered by ASTER data and the opportunity that this presents for remote glacial change analysis over regional extents. [J806]

"MIMO Radar Waveform Optimization With Prior Information of the Extended Target and Clutter"

The concept of multiple-input multiple-output (MIMO) radar allows each transmitting antenna element to transmit an arbitrary waveform. This provides extra degrees of freedom compared to the traditional transmit beamforming approach. It has been shown in the recent literature that MIMO radar systems have many advantages. In this paper, we consider the joint optimization of waveforms and receiving filters in the MIMO radar for the case of extended target in clutter. A novel iterative algorithm is proposed to optimize the waveforms and receiving filters such that the detection performance can be maximized. The corresponding iterative algorithms are also developed for the case where only the statistics or the uncertainty set of the target impulse response is available. These algorithms guarantee that the SINR performance improves in each iteration step. Numerical results show that the proposed methods have better SINR performance than existing design methods. [J807]

"On the Combination of Multisensor Data Using Meta-Gaussian Distributions"

With the ever-increasing number and diversity of Earth observation satellites, it steadily becomes more important to be able to analyze compound data sets consisting of different types of images acquired by different sensors. In this paper, we examine different ways of obtaining joint distributions of such images, and we propose a method that enables incorporation of correlations between images while keeping a good fit to the marginal distributions. The approach basically consists of two steps. First, the marginal densities are specified. Based on this specification, each marginal variable is transformed to a normal distributed variable. The joint distribution of the transformed variables is assumed to be multivariate normal. Transforming back to the original scale gives a joint distribution with dependence, where the initial marginal distributions are preserved. The parameters of the new joint distribution can be estimated. The focus is on marginal distributions that are Gamma, K, or Gaussian, although any distribution could be considered. The joint distributions produced by the transformation method can be used in supervised classification of radar and optical images. Results obtained for a set of four-look synthetic aperture radar (SAR) images, as well as a combination of SAR and optical images, are presented. [J808]

"Use of a Frequency-Hopping Radar for Imaging and Motion Detection Through Walls"

A small frequency-agile radar has been developed and configured into different systems for performing imaging of static and dynamic targets through common building materials. Radar operating parameters are defined through software control, allowing radar system operations to be tailored to operational needs. Field testing has shown the radar's ability to detect stationary individuals concealed behind concrete walls at significant ranges. [J809]

"Alternatives to Target Entropy and Alpha Angle in SAR Polarimetry"

The purpose of this paper is to discuss two polarimetric parameters which are widely used in synthetic aperture radar (SAR) polarimetry, namely, target entropy and alpha angle. We propose alternative parameters based on our analysis on how they are connected to covariance matrix similarity invariants and how they can be physically interpreted in optical polarimetry. The proposed alternatives can be computed by a fairly simple algorithm and even by the use of software without complex mathematics abilities. As an example, a NASA/Jet Propulsion Laboratory Airborne SAR L-band image of the San Francisco Bay is used to compare the proposed parameter schemes with the original entropy and alpha. A coherent rationale for these alternative parameters is formulated in order to provide insight to polarimetric parameter interpretation. [J810]

"Polarimetric Backscattering Coefficients of Flooded Rice Fields at L- and C-Bands: Measurements, Modeling, and Data Analysis"

The polarimetric backscattering coefficients (vv-, hh-, hv-, and vh-polarizations) of a flooded rice field are measured using L- and C-band ground-based polarimetric scatterometers. These measurements were made during the rice growth cycle, i.e., from the transplanting period to the harvest period (May to October 2006), to understand the feasibility of modeling and estimating rice growth. We also collected ground truth data that include fresh and dry biomasses, plant height, leaf area index, and leaf size. To study the incidence angle effect, the scatterometer data were collected at four different incidence angles, i.e., 30deg, 40deg, 50deg, and 60deg. In this paper, we show that the backscattering coefficients of a rice field can accurately be modeled using the radiative transfer theory. We also demonstrate that a polarimetric scatterometer is an effective tool for estimating rice growth. The hh-polarized backscattering coefficient is more sensitive to rice growth than its vv-polarization counterpart. The polarimetric ratio can be used to estimate rice growth accurately. [J811]

"Quantifying Bird Density During Migratory Stopover Using Weather Surveillance Radar"

Increasingly, data from weather surveillance radars are being used by biologists investigating the ecology and behavior of birds, insects, and bats in the aerosphere. Unfortunately, these radars quantify echoes caused by layered biological targets such as migrating birds in a manner that introduces bias in radar measures. We investigated the performance of a bias-adjustment algorithm that adjusts radar measures for vertical variation of reflectivity, nonstandard beam refraction, and spatial displacement of radar targets. We evaluated the efficacies of four variations of this algorithm by their ability to increase correspondence between radar reflectivity measured at two weather radar sites and the ground density of migrating birds measured during two autumn seasons and two spring seasons among 24 hardwood forest sites along the northern coast of the Gulf of Mexico. The algorithm integrated close-range reflectivity data from the five lowest elevation angle sweeps to derive high-resolution vertical profiles of reflectivity (VPRs) that closely corresponded to the observed vertical target density profiles based on a vertically oriented portable radar. The radar reflectivity of birds aloft near the onset of migratory flight was positively correlated with the bird density on the ground. All four radar data adjustment schemes that we tested produced significant improvement in the accuracy of bird density estimates relative to unadjusted radar data. In general, adjusting reflectivity based solely on the VPRs derived using observed refractive conditions yielded the most accurate radar-based estimates of bird density. [J812]

"Impact of Hillslope-Scale Organization of Topography, Soil Moisture, Soil Temperature, and Vegetation on Modeling Surface Microwave Radiation Emission"

Microwave radiometry will emerge as an important tool for global remote sensing of near-surface soil moisture in the coming decade. In this modeling study, we find that hillslope-scale topography (tens of meters) influences microwave brightness temperatures in a way that produces bias at coarser scales (kilometers). The physics underlying soil moisture remote sensing suggests that the effects of topography on brightness temperature observations are twofold: 1) the spatial distribution of vegetation, moisture, and surface and canopy temperature depends on topography and 2) topography determines the incidence angle and polarization rotation that the observing sensor makes with the local land surface. Here, we incorporate the important correlations between factors that affect emission (e.g., moisture, temperature, and vegetation) and topographic slope and aspect. Inputs to the radiative transfer model are obtained at hillslope scales from a mass-, energy-, and carbon-balance-resolving ecohydrology model. Local incidence and polarization rotation angles are explicitly computed, with knowledge of the local terrain slope and aspect as well as the sky position of the sensor. We investigate both the spatial organization of hillslope-scale brightness temperatures and the sensitivity of spatially aggregated brightness temperatures to satellite sky position. For one computational domain considered, hillslope-scale brightness temperatures vary from approximately 121 to 317 K in the horizontal polarization and from approximately 117 to 320 K in the vertical polarization. Including hillslope-scale heterogeneity in factors effecting emission can change watershed-aggregated brightness temperature by more than 2 K, depending on topographic ruggedness. These findings have implications for soil moisture data assimilation and disaggregation of brightness temperature observations to hillslope scales. [J813]

"Motion Compensation for UAV SAR Based on Raw Radar Data"

Unmanned aerial vehicle (UAV) synthetic aperture radar (SAR) is very important for battlefield awareness. For SAR systems mounted on a UAV, the motion errors can be considerably high due to atmospheric turbulence and aircraft properties, such as its small size, which makes motion compensation (MOCO) in UAV SAR more urgent than other SAR systems. In this paper, based on 3-D motion error analysis, a novel 3-D MOCO method is proposed. The main idea is to extract necessary motion parameters, i.e., forward velocity and displacement in line-of-sight direction, from radar raw data, based on an instantaneous Doppler rate estimate. Experimental results show that the proposed method is suitable for low- or medium-altitude UAV SAR systems equipped with a low-accuracy inertial navigation system. [J814]

"Bistatic SAR Data Focusing Using an Omega-K Algorithm Based on Method of Series Reversion"

This paper deals with an omega-K algorithm for focusing bistatic synthetic aperture radar (SAR) data. The key of the proposed algorithm is the derivation of a frequency mapping function by using Neo's method of series reversion. The registration of the focused image onto the ground plane is discussed in detail, which is based on a conclusion that the targets whose instantaneous Doppler frequencies at zero azimuth time are the same as that of the reference target at zero azimuth time will all be focused at the reference target's azimuth position in the focused image. The range invariance region size, which the proposed algorithm can process, is also determined in this paper. The proposed algorithm can handle extreme bistatic configurations with wide apertures and large squint angles. The effectiveness of the proposed algorithm is confirmed by simulation results. Although

developed for the azimuth-invariant case, the proposed algorithm can be readily extended to the azimuth-variant case, as long as we divide the SAR data into blocks in the azimuth direction so that each block of SAR data can be assumed quasi-stationary in the azimuth direction. [J815]

"A Spatially Adjusted Elevation Model in Dronning Maud Land, Antarctica, Based on Differential SAR Interferometry"

In this paper, a new digital elevation model (DEM) is derived for the ice sheet in western Dronning Maud Land, Antarctica. It is based on differential interferometric synthetic aperture radar (SAR) from the European Remote Sensing 1/2 (ERS-1/2) satellites, in combination with ICESat's Geoscience Laser Altimeter System (GLAS). A DEM mosaic is compiled out of 116 scenes from the ERS-1 ice phase in 1994 and the ERS-1/2 tandem mission between 1996 and 1997 with the GLAS data acquired in 2003 that served as ground control. Using three different SAR processors, uncertainties in phase stability and baseline model, resulting in height errors of up to 20 m, are exemplified. Atmospheric influences at the same order of magnitude are demonstrated, and corresponding scenes are excluded. For validation of the DEM mosaic, covering an area of about 130 000 km2on a 50-m grid, independent ICESat heights (2004-2007), ground-based kinematic GPS (2005), and airborne laser scanner data (ALS, 2007) are used. Excluding small areas with low phase coherence, the DEM differs in mean and standard deviation by 0.5 + /-10.1, 1.1 + /-6.4, and 3.1 +/-4.0 m from ICESat, GPS, and ALS, respectively. The excluded data points may deviate by more than 50 m. In order to suppress the spatially variable noise below a 5-m threshold, 18% of the DEM area is selectively averaged to a final product at varying horizontal spatial resolution. Apart from mountainous areas, the new DEM outperforms other currently available DEMs and may serve as a benchmark for future elevation models such as from the TanDEM-X mission to spatially monitor ice sheet elevation. [J816]

"Unsupervised Change Detection From Multichannel SAR Data by Markovian Data Fusion"

In applications related to environmental monitoring and disaster management, multichannel synthetic aperture radar (SAR) data present a great potential, owing both to their insensitivity to atmospheric and Sun-illumination conditions and to the improved discrimination capability they may provide as compared with single-channel SAR. However, exploiting this potential requires accurate and automatic techniques to generate change maps from (multichannel) SAR images acquired over the same geographic region in different polarizations or at different frequencies at different times. In this paper, a contextual unsupervised change-detection technique (based on a data-fusion approach) is proposed for two-date multichannel SAR images. Each SAR channel is modeled as a distinct information source, and a Markovian approach to data fusion is adopted. A Markov random field model is introduced that combines together the information conveyed by each SAR channel and the spatial contextual information concerning the correlation among neighboring pixels and formulated by using ldquoenergy functions.rdquo In order to address the task of the estimation of the model parameters, the expectation-maximization algorithm is combined with the recently proposed ldquomethod of log-cumulants.rdquo The proposed technique was experimentally validated with semisimulated multipolarization and multifrequency data and with real SIR-C/XSAR images. [J817]

"An Improvement of the Performance of Multiple-Aperture SAR Interferometry (MAI)"

Multiple-aperture synthetic aperture radar (SAR) interferometry (MAI) enables the measurement of along-track surface deformations by means of split-beam SAR processing. This paper examines the effects of flat-Earth and topographic phases on the MAI phase and derives formulas to correct them. Detailed MAI processing steps are introduced and discussed with particular consideration given to coherence improvement, as well as to computational efficiency. Forward- and backward-looking MAI pairs have different perpendicular baselines, which play a key role in phase distortion; consequently, an orbital deviation of only a few centimeters could result in a significant flat-Earth phase. A second-order polynomial model was used to estimate the perpendicular baseline difference. European Remote Sensing 2 satellite SAR data sets of the Hector Mine earthquake event in 1999 were used for performance evaluation. The proposed processing with the flat-Earth and topographic phase corrections achieved precision of along-track deformation ranging from 10.2 to 13.1 cm. Two coseismic pairs were compared and the standard deviation of the difference between the two independent measurements was 7.0 cm, with a mean difference of -0.24 cm. Thus, the measurement accuracy of MAI was improved using flat-Earth correction and coherence enhancement. [J818]

"CFAR Detection Strategies for Distributed Targets Under Conic Constraints"

In this paper we deal with the problem of adaptive detection of mismatched mainlobe targets and/or sidelobe interfering signals that are distributed in range. To this end, we investigate the impact of modeling the actual useful signal as a vector belonging to a proper cone with axis the nominal steering vector as a means to

improve the robustness of the decision rule in presence of mainlobe targets; similarly, in order to improve the rejection capabilities of the decision rule in presence of sidelobe interferers we study the effects of replacing the usual noise-only hypothesis with a noise-plus-interferers hypothesis where interferers belong to the complement of a cone with axis the nominal steering vector. At the design stage we resort to the two-step GLRT-based design procedure; to this end, we assume that a set of training data is available, namely data free of signal components, but sharing the same Gaussian distribution of the noise in the cells under test. Remarkably, proposed detectors possess the CFAR property under the noise-only hypothesis. The performance assessment, conducted by Monte Carlo simulation, is aimed at assessing the effectiveness of proposed solutions, also in comparison to existing ones. [J819]

"Focusing Spaceborne/Airborne Hybrid Bistatic SAR Data Using Wavenumber-Domain Algorithm"

This paper focuses on the bistatic synthetic aperture radar (SAR) data processing in a spaceborne/airborne hybrid bistatic configuration. Due to the extreme differences in platform velocities and slant ranges, the airborne system operates in the inverse sliding-spotlight mode, while the spaceborne system works in the sliding-spotlight mode to achieve a tradeoff between azimuth scene size and azimuth resolution. In this extreme bistatic configuration, our original bistatic formula shows a limitation of accurately describing the bistatic point-target reference spectrum, owing to the assumption of equal contributions of transmitter and receiver to the total Doppler spectrum. We extend our previous formula using the weighting operation where the weighting factor is the ratio of the azimuth time-bandwidth product (TBP) of the platform to the total azimuth TBP. In this paper, the bistatic-deformation and azimuth-dependent range-cell-migration terms were removed with phase multiplications performed blockwise in range-azimuth subsections. The remaining quasi-monostatic term shows the characteristic of the conventional monostatic SAR besides an additional azimuth-scaling term. For the monostatic characteristic, any precision monostatic SAR processing algorithms can handle. In this paper, we prefer the wavenumber-domain algorithm (also known as Omega-K), since it can accurately correct the range dependence of the range-azimuth coupling, as well as the azimuth-frequency dependence. For the azimuth-scaling term, an inverse scaled Fourier transformation is performed to correct it. Finally, a hybrid spaceborne/airborne simulation experiment is conducted to validate the proposed processing procedure. [J820]

"Radar Volume Backscatter From Spatially Extended Geophysical Targets in a "Slice" Approach"

This paper presents an assessment of the radar backscatter from a spatially extended geophysical target (SEGT) based on a semiempirical (SE) model. An SEGT is any geophysical object that is at least semitransparent to radar illumination (clouds, rain, snowfall in the atmosphere, thick snow cover of the ground). The existing SE model does not take into account the statistical properties of the SEGT's media. To improve the SE model, a so-called ldquoslicerdquo approach is applied. In this approach, the particles located close to the wavefront of the radar illumination are assumed to produce backscatter that is mainly coherent. This method allows the contribution of the microphysical parameters of the scattering media to the volume component of the radar cross section to be described more comprehensively than the SE model based on the incoherent approach. It is shown that the slice concept results in the original SE model in the particular case when the particle number fluctuation within the slices pertains to the Poisson law. [J821]

"A New Microwave Axial Tomograph for the Inspection of Dielectric Materials"

In this paper, the development of a microwave axial tomograph for the inspection of dielectric materials is discussed. In particular, hardware and software solutions are pointed out. An experimental bistatic imaging setup is described. Moreover, the results of several forward-scattering simulations, which are aimed at defining suitable working conditions, are reported. Finally, to invert the collected field-scattered data, a deterministic inexact Newton method is applied. The approach is evaluated by using synthetic data, and the results of a preliminary experimental reconstruction are reported. [J822]

"Signal processing: A view of the future, Part 2 [JExploratory DSP]"

The intent of the author in this column and its predecessor, published in the March 2009 issue of IEEE Signal Processing Magazine, was to produce a behavioral model for the field of signal processing and then use that model to predict the field's future. With the arc of the field thus estimated, coherent recommendations could then be made about how we might best work together to maximize its potential and achieve the positive societal outcomes it can produce. [J823]

"Fundamentals of Radar Signal Processing (Richards, M.A.; 2005) [JBook review]"

This book introduces the fundamental concepts of radar by building upon digital signal processing concepts. It provides a thorough covering of all of the basic radar topics, in addition to more advanced topics, such as CFAR

detection, synthetic aperture radar (SAR), and space-time adaptive processing (STAP). The book is clear, concise, and informative, and represents a valuable resource for both the classroom and the professional world. [J824]

"Monitoring Sugarcane Growth Using ENVISAT ASAR Data"

The objective of this paper is to investigate potential of satellite C-band synthetic aperture radar (SAR) radar in monitoring sugarcane growth in southern China. This paper proposes a method to map sugarcane growing area and retrieve sugarcane leaf area index (LAI) in different growth stages using ENVISAT Advanced SAR (ASAR) alternating polarization HH/HV data. The temporal response of ASAR alternating polarization HH/HV data to sugarcane fields and sugarcane LAI was first analyzed in the study area. The analysis shows that sugarcane fields have increasing temporal radar response trend with sugarcane growth and ratio of ASAR HV to HH data has a better correlation with the increase of sugarcane LAI. A theoretical radiative transfer model was adopted to interpret the trend. Based on the temporal variation of the radar response of sugarcane fields, a method for mapping sugarcane planting area was developed using ASAR HH and HV polarization data at two acquisition dates with a certain classification accuracy. The empirical models were also established to estimate LAI of sugarcane using the HV/HH polarization ratio. The results suggest that C-band ASAR data appear promising in the development of an operational system for monitoring sugarcane growth in southern China. [J825]

"Noninvasive Biosignal Detection Radar System Using Circular Polarization"

This paper proposes an integrated hypersensitive Doppler radar system through a circular polarization characteristic. Through the idea of a reverse sense of rotation when the reflecting surface is perfectly conducting, it is shown that the detecting property of the system can be effectively improved by using antennas that have a reverse polarization. This bistatic radar system can be used in noninvasively sensing biosignals such as respiration and heart rates with the periodic movement of skin and muscle near the heart. The operating frequency of the system is in the X-band and the radar size is 95 times 50 times 13 mm3. [J826]

"An L-Band Ocean Geophysical Model Function Derived From PALSAR"

This paper examines L-band normalized radar cross section (NRCS) dependence on ocean surface wind. More than 90 000 match-ups, each consisting of the L-band HH NRCS, incidence angles, wind speeds, and wind directions, were collected from the Phased-Array L-Band Synthetic Aperture Radar (PALSAR) and scatterometer wind vectors. Based on the match-ups, the L-band HH NRCS dependence on incidence angle and wind vector is modeled for 0-20-m/s wind speeds and 17deg-43deg incidence angles. The derived relation indicates that the wind sensitivity of the L-band NRCS is less than that of the C-band at moderate winds and large incidence angles, whereas comparable at stronger winds ((>10 m/s) and small incidence angles. The upwind-crosswind difference is amplified in the 10-15-m/s range followed by an almost zero amplitude from 4 to 8 m/s, which represents a clear phase shift with the C-band VV and Ku-band HH models. Wind speeds are then estimated from the match-ups, based on the derived model function. A comparison with the reference scatterometer winds reveals a 0.05-m/s bias and a 1.85-m/s root mean square error, where crosswind data give rise to large errors due to low wind sensitivity at wind speeds of around 10 m/s, particularly at large incidence angles. The L-band NRCS behavior in strong winds (>20 m/s), at which the C-band is saturated, was not determined in the current model due to the limited number of the match-ups. [J827]

"Injection Heights of Biomass Burning Debris Estimated From WSR-88D Radar Observations"

Understanding the vertical distribution of aerosols is critical to accurately determining their effects on air quality. Since current tools for obtaining this information have limited spatial and temporal coverage, we explore the use of Doppler radar data for obtaining the injection heights of biomass burning debris (BBD) produced from large fires in southern Georgia during Spring 2007. Due to their submicrometer sizes, the smoke aerosols are not detected by the radar. Therefore, we use BBD as a possible surrogate for aerosol height since smoke aerosols are often collocated with the debris. Using 32 h of Weather Surveillance Radar-1988 Doppler (WSR-88D) radar data from Jacksonville, FL, between May 23 and 25, 2007, the injection heights of BBD (D ~ 1mm) are calculated. Our analysis indicates that the maximum injection height is ~5 km for the strongest fire, with a mean injection height of 3 plusmn 1.0 km. Maximum injection heights are present between 1800 and 0000 UTC, during the late afternoon periods when both the intensity of the fire (based on radar information) and the convective mixing are greatest. The injection heights estimated from this approach represent the first step at providing inputs for future air-quality forecasting applications within numerical simulations, particularly ones that require diurnal information. [J828]

"Ultrawideband (UWB) Radar Imaging of Building Interior: Measurements and Predictions"

In this paper, we explore using the ultrawideband radar technology for sensing through-the-wall imaging. We conducted a field experiment with our in-house designed impulse-based radar, in which a stripmap synthetic aperture radar (SAR) geometry was employed in mapping an abandoned army barrack building with a large footprint area. The images obtained from two sides of the building were combined in order to obtain the full building layout, including the interior structure. Computer simulations performed with Xpatch, a physical optics-based ray tracing code, are used to explain some phenomena observed in the measured SAR images. [J829]

"On Designing Sequences With Impulse-Like Periodic Correlation"

Sequences with impulse-like correlations are at the core of several radar and communication applications. Two criteria that can be used to design such sequences, and which lead to rather different results in the aperiodic correlation case, are shown to be identical in the periodic case. Furthermore, two simplified versions of these two criteria, which similarly yield completely different sequences in the aperiodic case, are also shown to be equivalent. A corollary of these unexpected equivalences is that the periodic correlations of an arbitrary sequence must satisfy an intriguing identity, which is also presented in this letter. [J830]

"Unsupervised Synthetic Aperture Radar Image Segmentation Using Fisher Distributions"

A new and fast unsupervised technique for segmentation of high-resolution synthetic aperture radar (SAR) images into homogeneous regions is proposed. This technique is based on Fisher probability density functions (pdfs) of the intensity fluctuations and on an image model that consists of a patchwork of homogeneous regions with polygonal boundaries. The segmentation is obtained by minimizing the stochastic complexity of the image. Different strategies for the pdf parameter estimation are analyzed, and a fast and robust technique is proposed. Finally, the relevance of the proposed approach is demonstrated on high-resolution SAR images. [J831]

"Experiments and Algorithms to Detect Snow Avalanche Victims Using Airborne Ground-Penetrating Radar"

Snow avalanche victims have only a good chance to survive when they are located within a short time. This requires an active beacon for them to wear or a very rapid deployment of a search-and-rescue team with dogs. Customary ground-penetrating radar (GPR) instruments used on the snow surface are not able to reduce fatality numbers because they are slow to search a field. A potential alternative could be an airborne search using radar. An airborne radar search is technologically challenging because a very large data stream has to be processed and visualized in real time, and the interaction of the electromagnetic waves with snow, subsurface, and objects must be understood. We studied a two-step algorithm to locate avalanche victims in real time. The algorithm was validated using realistic test arrangements and conditions using an aerial tramway. The distance dependence of the reflection energy with increased flight heights, the coherence between the use of more antennas and the detectable range, and the reflection images of different avalanche victims were measured. The algorithm detected an object for each investigated case, where the reflection energy of the scans was higher than for the scans of pure snow. Airborne GPR has a large potential to become a rapid search method in dry snow avalanches. However, a fully operational version still requires substantial improvements in hardware and software. [J832]

"On the performance analysis of composite multipath/shadowing channels using the G-distribution"

Composite multipath fading/shadowing environments are frequently encountered in different realistic scenarios. These channels are generally modeled as a mixture of Nakagami-m multipath fading and log-normal shadowing. The resulting composite probability density function (pdf) is not available in closed form, thereby making the performance evaluation of communication links in these channels cumbersome. In this paper, we propose to model composite channels by the G-distribution. This pdf arises when the log-normal shadowing is substituted by the inverse-Gaussian one. This substitution will prove to be very accurate for several shadowing conditions. In this paper we conduct a performance evaluation of single-user communication systems operating in a composite channel. Our study starts by deriving an analytical expression for the outage probability. Then, we derive the moment generating function of the G-distribution, hence facilitating the calculation of average bit error probabilities. We also derive analytical expressions for the channel capacity for three adaptive transmission techniques, namely, i) optimal rate adaptation with constant power, ii) optimal power and rate adaptation, and iii) channel inversion with fixed rate. [J833]

"Study of Hypersaline Deposits and Analysis of Their Signature in Airborne and Spaceborne SAR Data: Example of Death Valley, California"

Field measurements of dielectric properties of hypersaline deposits were realized over an arid site located in

Death Valley, CA. The dielectric constant of salt and water mixtures is usually high but can show large variations, depending on the considered salt. We confirmed values observed on the field with laboratory measurements and used these results to model both the amplitude and phase behaviors of the synthetic aperture radar (SAR) signal at C- and L-bands. Our analytical simulations allow reproducing specific copolar signatures observed in both Airborne SAR (AIRSAR) and Spaceborne Imaging Radar (SIR-C) data, corresponding to the saltpan of the Cottonball Basin. More precisely, the main objective of the present paper is to understand the influence of soil salinity as a function of soil moisture on the dielectric constant of soils and then on the backscattering coefficients recorded by airborne and spaceborne SAR systems. We also propose the copolarized backscattering ratio and phase difference as indicators of moistened and salt-affected soils. More precisely, we show that these copolar indicators should allow monitoring of the seasonal variations of the dielectric properties of saline deposits at both C- and L-bands. Because of the frequency dependence of the ionic conductivity, we also show that L-band SAR systems should be efficient tools for detecting both soil moisture and salinity, while C-band SAR systems are more suitable for the monitoring of soil moisture only. Through the study of terrestrial evaporitic environments by means of spaceborne SAR systems, our results could also be of great interest for defining future planetary missions, particularly for the exploration of Mars. [J834]

"Planar antenna for directive beam steering at end-fire using an array of surface-wave launchers"

A planar surface-wave antenna (SWA) that achieves radiation at end-fire by surface-wave (SW) excitation is presented for millimetre-wave frequencies of operation. The 2D SWA is fed by a two-element array of printed SW launchers for controlled beam steering in the far-field. Measured results demonstrate a highly directive beam pattern with a 3 dB beamwidth less than 5 at 22.71 GHz. Such a planar low-cost and low-profile SWA design may be advantageous for surveillance systems and radar applications where beam steering at end-fire is of interest. [J835]

"On-Ground Characterization of the SMOS Payload"

The on-ground characterization of the synthetic aperture radiometer onboard the Soil Moisture and Ocean Salinity mission is described. Characterization includes basic functionality, internal calibration, thermal cycling, response to point and flat sources, self-radio-frequency interference, and others. The description of the different tests performed as well as the detailed results are provided. The results show that the instrument is very stable and has all gains and offsets consistent with the ones obtained at subsystem level. On the other hand, the phase of the visibility has a larger variation with temperature than expected, a small signal leakage from the local oscillators is present, and a small interference from the X-band transmitter during short periods of time has been detected. The implementation of internal-calibration procedures, along with the accurate thermal characterization performed, have been used to produce highly accurate brightness-temperature values well within specifications. [J836]

"Detection of Single Scatterers in Multidimensional SAR Imaging"

Multidimensional synthetic aperture radar (SAR) imaging is a technique based on coherent SAR data combination for space (full 3-D) and space deformation-velocity (4-D) analysis. It is an extension of the concepts of SAR interferometry and differential interferometry SAR and offers new options for the analysis and monitoring of ground scenes. In this paper, we consider the problem of detecting single scatterers for localization and monitoring issues. To this end, we resort to a constant false alarm rate (CFAR) detection scheme which can be synthesized according to three different design criteria: generalized likelihood ratio test, Rao test, and Wald test. At the analysis stage, the performance of the aforementioned detector is compared to that of a previously proposed CFAR scheme, based on the multi-interferogram complex coherence and widely used in persistent scatterer interferometry. The analysis is conducted both on simulated and on real SAR data, acquired by ERS-1/2 satellites. Finally, Cramer-Rao lower bounds for the estimation of the scatterer elevation and velocity are provided. [J837]

"A 77-GHz FMCW MIMO Radar Based on an SiGe Single-Chip Transceiver"

This paper describes a novel frequency-modulated continuous-wave radar concept, where methods like nonuniform sparse antenna arrays and multiple-input multiple-output techniques are used to improve the angular resolution of the proposed system. To demonstrate the practical feasibility using standard production techniques, a prototype sensor using a novel four-channel single-chip radar transceiver in combination with differential patch antenna arrays was realized on off-the-shelf RF substrate. Furthermore, to demonstrate its practical applicability, the assembled system was tested in real world measurement scenarios in conjunction with the presented efficient signal processing algorithms. [J838]

"An Improved Soil Moisture Retrieval Algorithm for ERS and METOP Scatterometer Observations"

The scatterometers onboard the European Remote Sensing satellites (ERS-1 & ERS-2) and the METeorological OPerational satellite (METOP) have been shown to be useful for surface soil moisture retrieval using the so-called TU-Wien change detection method. This paper presents an improved soil moisture retrieval algorithm based on the existing TU-Wien method but with new parameterization as well as a series of modifications. The new algorithm, WAter Retrieval Package 5 (WARP5), copes with some limitations identified in the earlier method WARP4 and provides the possibility of migrating soil moisture retrieval from ERS-SCAT to METOP-ASCAT data. The WARP5 algorithm results in a more robust and spatially uniform soil moisture product, thanks to its new processing elements, including a method for the correction of azimuthal anisotropy of backscatter, a comprehensive noise model, and new techniques for calculation of the model parameters. Cross-comparisons of WARP4 and WARP5 data sets with the Oklahoma Mesonet insituobservations and also with European Centre of Medium Range Weather Forecast (ECMWF) ReAnalysis (ERA-Interim) global modeled data show that the new algorithm has a better performance and effectively corrects retrieval errors in certain areas. [J839]

"Special Issue on Remote Sensing of Building Interior"

The 15 papers in this special issue focus on remote sensing of building interior and can be categorized into: 1) system design and instrumentation; 2) advanced imaging techniques for elimination of glint from large flat wall structures; 3) radar polarimetry; 4) passive microwave radiometry; 5) advanced forward models based on high-frequency methods as well as full-wave solutions based on finite-difference time-domain technique for large-scale problems; and 6) detection and identification techniques of behind the wall stationary and moving concealed and unconcealed targets. [J840]

"Intercomparison of Ground-Based Radar and Satellite Cloud-Top Height Retrievals for Overcast Single-Layered Cloud Fields"

The objective of this paper is to assess the accuracy of the Semi-Analytical CloUd Retrieval Algorithm (SACURA) that retrieves cloud-top heights (CTHs) using hyperspectral SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) onboard Environmental Satellite measurements for overcast single-layer cloud fields. Intercomparisons with ground-based 35-GHz millimeter wave cloud radar CTHs were performed for 14 dates during 2003-2007 at the U.S. Atmospheric Radiation Measurement (ARM) program Southern Great Plains site (36.6deg N, 97.5deg W). In addition, for some of these dates, European Space Agency MEdium Resolution Imaging Spectrometer (MERIS) and the NASA-TERRA Moderate Resolution Imaging Spectroradiometer (MODIS) cloud-top pressure retrievals were also collected, transformed into CTHs using nearby ARM radiosonde profiles, and compared with the SACURA SCIAMACHY and radar retrievals. The accuracy of the SACURA-SCIAMACHY CTH retrievals is better than 0.34 km for low-level clouds and 2.22 km for high-level clouds with an underestimate in CTH on average for all clouds. The average bias in SCIAMACHY CTHs was about 0.07 km for low clouds and about 0.5 km for high-level clouds. Both MODIS and MERIS slightly overestimated the CTHs of low-level clouds by 300 m, with an uncertainty better than 1 km. However, although MODIS accuracy for high-level clouds is close to SCIAMACHY, MERIS CTHs were significantly underestimated for these fairly optically thick cases. [J841]

"The Two-Scale BPM Scattering Model for Sea Biogenic Slicks Contrast"

Sea oil slick observation by means of synthetic aperture radar is still a scientific and operational challenge. In this paper, the sea surface scattering with and without biogenic slicks is analyzed by using the two-scale Boundary Perturbation Method scattering model. The surface slick is supposed to modify both the full-range sea surface spectrum and the slope probability density function by means of the Marangoni damping and by a reduced friction velocity. In this paper, the full-range Universite Catholique de Louvain sea surface spectrum is considered. A new contrast model, which overcomes the drawbacks of the contrast model based on the untilted Small Perturbation Method scattering model, is presented and illustrated in some L- and C-band biogenic slick cases. [J842]

"Automatic Analysis of GPR Images: A Pattern-Recognition Approach"

In this paper, we propose a novel pattern-recognition system to identify and classify buried objects from ground-penetrating radar (GPR) imagery. The entire process is subdivided into four steps. After a preprocessing step, the GPR image is thresholded to put under light the regions containing potential objects. The third step of the system consists of automatically detecting the objects in the obtained binary image by means of a search of linear/hyperbolic patterns formulated within a genetic optimization framework. In the genetic optimizer, each chromosome models the apex position and the curvature associated with the candidate pattern, while the fitness function expresses the Hamming distance between that pattern and the binary image content. Finally, in the

fourth step, the problem of the recognition of the material type of the identified objects is approached as a classification issue, which is solved by means of an opportune feature-extraction strategy and a support vector machine classifier. To illustrate the performances of the proposed system, we conducted a thorough experimental study based on GPR images generated by a GPR simulator based on the finite-difference time-domain method so as to construct different acquisition scenarios by varying the number of buried objects, their position, their size, their shape, and their material type. In general, the obtained experimental results show that the proposed system exhibits promising performances both in terms of object detection and material recognition. [J843]

"Separation of Ground and Low Vegetation Signatures in LiDAR Measurements of Salt-Marsh Environments"

Light detection and ranging (LiDAR) has been shown to have a great potential in the accurate characterization of forest systems; however, its application to salt-marsh environments is challenging because the characteristic short vegetation does not give rise to detectable differences between first and last LiDAR returns. Furthermore, the lack of precisely identifiable references (e.g., buildings, roads, etc.) in marsh areas makes the registration and bias correction of the LiDAR data much more difficult than in conventional urban- or forested-area applications. In this paper, we introduce reliable methods to remove random and systematic errors and to register raw data, as well as a new procedure, to determine the optimal filter window size to separate ground and canopy returns. A limited amount of field observations is used to determine the size of the filtering window which produces the minimally biased estimates of the digital terrain model (DTM). The digital surface model (DSM, representing the canopy top) is then obtained in a similar manner, and the digital vegetation model (DVM, representing the vegetation height) is computed as the difference between the DSM and the DTM. We apply this procedure to a study marsh within the Venice Lagoon, Italy, and obtain a high-accuracy DTM. The error (z_LiDAR-z_field) is 2.2 cm, with a standard deviation of 6.4 cm. The comparison of the estimated DVM with field observations shows an underestimation of the height of the canopy top (17.7 cm, on average). The height of the lowest canopy elements (e.g., basal leaves), however, is significantly correlated to the LiDAR-derived DVM, showing that this contains useful information on the canopy structure. [J844]

"High-Power C- and X-Band Radar Helix TWTs"

Increase of average output power and bandwidth is a permanent trend of new radar systems to extend the range in high-jamming conditions. Thales Electron Devices has recently developed two traveling-wave tubes (TWTs) with high average output power in the C- and X-bands. helix TWTs were used to take advantage of the helix structure in terms of broad frequency bandwidth and linear characteristics. This paper presents the technical approach including simulations, technologies, and RF performances of these two TWTs. The first one delivers an output power of 25-kW peak and 1200-W average in the C-band for surface radar applications, and the second one delivers more than 8.5-kW peak and more than 500-W average in the X-band for airborne radar applications. [J845]

"Generalized Transition Matrix for Arbitrarily Shaped Scatterers With Composite Structures"

A scatterer is regarded as a one-port device, and an associated generalized transition matrix is defined uniquely to describe the relationships between the rotated tangential scattered field components and the rotated tangential incident field components on a specified reference surface. The reference surface can be moved to proper surfaces with regular shapes, or even be extended to include a group of scatterers with arbitrary shapes and different materials. Furthermore, scatterers connected with perfectly electric conducting (PEC) plates can also be handled with this one-port device model. Numerical results in two dimensions are provided to show that the generalized transition matrix is effective in analyzing large-scale scattering systems. [J846]

"Fault Tolerant Maximum Likelihood Event Localization in Sensor Networks Using Binary Data"

This paper investigates Wireless Sensor Networks (WSNs) for achieving fault tolerant localization of an event using only binary information from the sensor nodes. In this context, faults occur due to various reasons and are manifested when a node outputs a wrong decision. The main contribution of this paper is to propose the Fault Tolerant Maximum Likelihood (FTML) estimator. FTML is compared against the Centroid (CE) and the classical maximum likelihood (ML) estimators and is shown to be significantly more fault tolerant. Moreover, this paper compares FTML against the SNAP (Subtract on Negative Add on Positive) algorithm and shows that in the presence of faults the two can achieve similar performance; FTML is slightly more accurate while SNAP is computationally less demanding and requires fewer parameters. [J847]

"Laser Scanners for Driver-Assistance Systems in Intelligent Vehicles [JApplications of Control]"

Laser scanners find potential application in the automotive field for driver assistance and autonomous operation. Laser scanners that are commercially available are expensive compared to the cost of other commercial automotive sensors, limiting their implementation in cars at this time. The development in laser scanner technology and the anticipated reduced prices that will be available after mass production are expected to result in a growing market share in the near future. [J848]

"Development of High-Power Ka/Q Dual-Band and Communications/Radar Dual-Function Helix-TWT"

Future military communication systems on mobile satellite uplink platforms such as ground-based high-mobility vehicles and unmanned aerial vehicles (UAVs) and aircraft have strict constraints in size, weight, and power. Despite these constraints, these platforms also require ever-increasing data rate and bandwidth for video/imagery transmissions from small aperture terminals. In addition to the communications requirements, more UAV platforms, as an important part of current and future military operations, desire radar capabilities for ground mapping and visibility through poor weather conditions. In 2007, as part of an ongoing effort to meet these demands, L-3 Communications Electron Technologies, Inc. successfully developed a Ka/Q dual-band helix-traveling-wave tube, i.e., the 8923H, that produces 315 W minimum output power at Ka-band (30-31 GHz) and 200 W minimum output power at Q-band (43.5-45.5 GHz). The device was primarily developed to satisfy the Ka/Q dual-band communications requirements with power goals of 300 W minimum at Ka-band and 175 W at Q-band, but in addition, the device can also dual-function as a radar source in the Ka-radar-band (33-36 GHz) with peak power up to 400 W and duty demonstrated up to 50%, all from a single device. [J849]

"Partially Adaptive STAP using the FRACTA Algorithm"

A partially adaptive space-time adaptive processor (STAP) utilizing the recently developed FRACTA algorithm is presented which significantly reduces the high computational complexity and large sample support requirements of fully adaptive STAP. Multi-window post-Doppler dimensionality reduction techniques are employed to transform the data prior to application of the FRACTA algorithm. The FRACTA algorithm is a reiterative censoring (RC) and detection algorithm which has been shown to provide excellent detection performance in nonhomogeneous interference environments. Two multi-window post-Doppler dimensionality reduction techniques are considered: PRI-staggered and adjacent-bin. The partially adaptive FRACTA algorithm is applied to the KASSPER I (knowledge-aided sensor signal processing & expert reasoning) challenge datacube. The pulse repetition interval (PRI)-staggered approach with D=6 filters per Doppler bin is found to provide the best detection performance, outperforming the fully adaptive case while simultaneously reducing the runtime by a factor of ten. Using this implementation, partially adaptive FRACTA detects 197 out of 268 targets with one false alarm. The clairvoyant processor (the covariance matrix for each range cell is known) detects 198 targets with one false alarm. In addition, the partially adaptive FRACTA algorithm is shown to be resilient to jamming, and performs well for reduced sample support situations. When compared with partially adaptive STAP using traditional sliding window processing (SWP), the runtime of partially adaptive FRACTA is 14 times faster, and the detection performance is significantly increased (SWP detects 46 out of 268 targets with one false alarm). [J850]

"Adaptive Phased-Array Tracking in ECM using Negative Information"

Target tracking with adaptive phased-array radars in the presence of standoff jamming presents both challenges and opportunities to the track filter designer. A measurement likelihood function is derived for this situation which accounts for the effect of both positive and negative contact information. This likelihood function is approximated a? a weighted sum of Gaussian terms consisting of both positive and negative weights, accounting for the positive and negative contact information. Additionally, recent theoretical results have been reported which have derived an accurate measurement error covariance in the vicinity of the jammer when adaptive beamforming is used by the radar to null the effects of the jammer. We compare the impact of using a likelihood function that accounts for negative contact information and the corrected measurement error covariance by comparing five Kalman filter-based trackers in five different scenarios. We show that only those track filters which use both the negative contact information and the corrected measurement error covariance are effective in maintaining track on a maneuvering target as it passes through the jamming region. This approach can also be generalized to any target tracking problem where the sensor response is anisotropic. [J851]

"Development and Implementation of a Real-Time See-Through-Wall Radar System Based on FPGA"

This paper presents the development of a low-cost real-time ultrawideband (UWB) see-through-wall (STW) imaging radar system. The designs of the microwave front end, the UWB data acquisition, and the system integration are discussed in detail. As for the most challenging task, the UWB data acquisition, we introduce a

custom low-cost module based on commercial field-programmable gate array (FPGA) boards and low-speed analog-to-digital converters. The introduced module does not require a custom implementation of high-speed wideband mixed-signal circuitry but only depends on the FPGA firmware design, which favors a rapid system prototyping. The data acquisition module accomplishes a 100-ps equivalent-time sampling resolution at 100-Msamples/s real-time rate, while the developed STW system provides a 2-D real-time view of motion with a 1.5-ms speed behind walls. The system allows for an easy reconfiguration to support multiple operating frequency ranges, pulse sampling resolutions, and array deployments, thus providing a tremendous experimental flexibility. Our studies indicate that utilizing available technologies and off-the-shelf components could produce a practical stand-alone STW system at reasonable design effort and cost, which will lead to a better understanding of the challenging problems associated with STW technology. [J852]

"Gabor Filter Approach to Joint Feature Extraction and Target Recognition"

This paper presents a new approach of improving automatic target recognition (ATR) performance by tuning adaptively the Gabor filter. The Gabor filter adopts the network structure of two layers, and its input layer constitutes the adaptive nonlinear feature extraction part, whereas the weights between output layer and input layer constitute the linear classifier. From the statistic property of high-resolution range profile (HRRP), its extracted nonstationarity degree of features is tracked to extract the discriminative features of Gabor atoms. Two experimental examples show that the Gabor filter approach with simple structure has higher recognition rate in radar target recognition from HRRP as compared with several existing methods. [J853]

"Through-the-Wall SAR Attributed Scattering Center Feature Estimation"

We consider characterization of building interior structure from two-pass interferometric circular synthetic aperture radar data. We model returns from complex building structures as the sum of the responses from scattering primitives-plates, dihedrals, and trihedrals-observed through transfer functions that characterize both the transmission through and reflection from dielectric surfaces. Maximum-likelihood estimates for the location of primitive features and wall propagation/reflection parameters are obtained through a two-stage detection-and-estimation algorithm. We employ a sparse reconstruction algorithm to detect primitive signatures in the presence of wall effects and refine our estimates using a nonlinear minimization of local cost functions. We show that using simplified wall and primitive models, we can extract geometrically relevant features which can be combined to reveal 3-D floorplan estimates of buildings. Examples illustrate the effectiveness of the feature extraction approach. [J854]

"Design of Helix Pitch Profile for Broadband Traveling-Wave Tubes"

To improve the performance of a broadband traveling-wave tube (TWT), a helix pitch profile incorporating a section with reduced phase velocity followed by a positive phase-velocity taper is used. A simple technique to design a pitch profile of this kind is elaborated upon and later applied to an existing 6-18-GHz uniform pitch mini-TWT to improve its interaction efficiency. By using the newly designed helix, a TWT is developed, which shows increases in electronic efficiency and output power up to 8.75% points and 2.6 dB (75 W), respectively. Further application of this method to another uniform pitch baseline tube results in similar improvements. [J855]

"Phase-Coded Interrupted CW Signals and Processors"

High resolution radars require signals with large time-bandwidth product such as CW signal and coherent pulse train (CPT). We discuss a phase-coded interrupted CW (ICW) signal which is the combination of CW signal and CPT. Phase codes used here are with perfect periodic autocorrelation. The periodic ambiguity function of ICW signals is studied including single-carrier signal and multi-carrier signal. It is interesting that the gate function has different effects on two signals and contributes to a multi-carrier ICW signal which yields nearly perfect autocorrelation. Meanwhile we also suggest an efficient receiver approach to ICW signals, which can reduce the computational burden of the processor and utilize the good properties of P3 and P4 codes. [J856]

"New SAR Processor Based on Matched Subspace Detectors"

This paper deals with a new synthetic aperture radar (SAR) processor based on a subspace detector designed for man-made target (MMT) detection. As MMTs are more accurately described by a set of canonical elements than with isotropic points, we develop a new algorithm which aims at using new models, instead of the isotropic point model commonly used in SAR processors. A subspace detector matched to canonical elements is included in the SAR processing. The implementation and the optimization of subspace detector SAR (SDSAR) algorithm is described. Simple examples of MMT detection in simulations and real data with a target hidden in a forest show the power of our approach. The SDSAR algorithm is shown to be the first robust and tractable algorithm relying on realistic scattering assumptions about the target. [J857]

"SAR Images of Rooms and Buildings Based on FDTD Computer Models"

This paper presents synthetic aperture radar (SAR) images of rooms and buildings based on numerical simulations, with application to sensing through the wall (STTW) scenarios. We use the finite-difference time-domain modeling technique to compute the radar return from configurations of increasing complexity, where humans and furniture objects are placed in a room. We apply SAR image formation techniques and analyze the images obtained for various wall materials, aspect angles, and radar parameters. We investigate the multipath propagation issues relevant to STTW imaging radar and discuss the radar parameter tradeoff based on image quality. We also look at images obtained in cross-polarization, demonstrating how this radar operational mode can achieve significant clutter rejection. The phenomenological results obtained in this paper can be used as guidance by radar engineers in order to optimize the performance of STTW SAR imaging systems. [J858]

"High-Resolution Three-Dimensional Imaging of Spinning Space Debris"

Since space debris could post a significant threat to orbiting objects around the Earth, their reorganization, measurement, and catalogue are of great importance. This paper establishes a 3-D inverse synthetic aperture radar (ISAR) imaging geometry and signal model for space debris. Then, a 3-D imaging algorithm is proposed to realize coherent imaging in the range-slow-time domain. This algorithm is based on the complex-valued back-projection transform according to the spinning nature of space debris. The simulation results for both point scattering and continuous targets have proved the validity of the proposed algorithm. [J859]

"Predicting Topographic and Bathymetric Measurement Performance for Low-SNR Airborne Lidar"

Government and commercial airborne light detection and ranging (lidar) systems have enabled extensive measurements of the Earth's surface and land cover over the past decade. There is much interest, however, in employing smaller lidar systems that require less power to enable sensing from small unmanned aerial vehicles or satellites. Technological advances in the performance of small microlasers and photodetector sensitivity have recently enabled the development of experimental airborne lidar systems with low signal-to-noise ratios (LSNRs). Recent government and academic prototypes have indicated that LSNR airborne lidars could significantly increase the fidelity of terrain reconstruction over what is possible with existing conventional lidars. Thus, there is a need to build up a modeling capability for such systems in order to aid in future system and mission design. A numerical sensor simulator has been developed to model the expected returns from LSNR microlaser altimeter systems and predict their performance. Both optical and signal processing system components are considered, along with other factors, including atmospheric effects and surface conditions. Topographic (solid Earth) and bathymetric (littoral zone) measurement scenarios are considered. The analysis of topographic simulation data focuses on the effect of solar noise on SNR and elevation accuracy while bathymetric performance is evaluated with regard to water depth and scan angle for different water clarities. The mission conditions chiefly responsible for limiting the performance of LSNR lidar are discussed in detail, along with suggestions for further algorithm development and system performance evaluation. [J860]

"Target Detection in Clutter Using Adaptive OFDM Radar"

We address the problem of detecting a target moving in clutter environment using an orthogonal frequency division multiplexing (OFDM) radar. The broadband OFDM signal provides frequency diversity to improve the performance of the system. First, we develop a parametric model that accounts for the measurements at multiple frequencies including the Doppler shift. Then, we present a statistical detection test and evaluate its performance characteristics. Based on this, we propose an algorithm to adaptively design the parameters for the next transmitting waveform. Numerical examples illustrate our analytical results, demonstrating the achieved performance improvement due to the OFDM signaling method and adaptive waveform design. [J861]

"A Matched-Filter-Bank-Based 3-D Imaging Algorithm for Rapidly Spinning Targets"

For rapidly spinning targets, such as the rotating ground radar antenna, helicopter blades, spinning space debris, etc., the scatterers on the target may rotate for several periods in the observation time. Since the range and Doppler information of these scatterers are no longer constant, the conventional range-Doppler-based imaging algorithms are invalid. Meanwhile, 3-D imaging is necessary to obtain additional information for the spinning target. However, the available interferometric inverse synthetic radar (ISAR) and snapshot 3-D imaging algorithms do not work well since they require low target spinning speed. In this paper, a matched-filter-bank-based 3-D imaging algorithm for rapidly spinning targets is proposed, based on target motion features. This algorithm utilizes the rapidly rotating turntable model of the ISAR target instead of the slow rotating one. First, 2-D image slices of the target are obtained from the output of the matched filter bank by changing matching parameters. Then, a series of 2-D image slices are combined to form the 3-D target image. Since this algorithm

applies to the monostatic radar system, it is easy to implement in practical applications. Both the theoretical derivation and the simulation results have proved the validity of the proposed algorithm. [J862]

"A Comparison of the Impact of QuikScat and WindSat Wind Vector Products on Met Office Analyses and Forecasts"

Several studies have demonstrated that retrievals of wind vectors from the WindSat polarimetric radiometer are of sufficient quality to be considered for assimilation in operational numerical weather prediction models. In this paper, WindSat data are used in a state-of-the-art global meteorological analysis and forecasting system. Each wind vector contains a directional ambiguity and so is assimilated in a similar way to that of scatterometer data. The forecast impact of using analyses containing information from WindSat data was investigated for a period during August and September of 2005, when a large number of tropical cyclones were present. Forecast errors were reduced in the surface pressure fields, and the average improvement across the forecast range was found to be 1.0%. This is comparable to the improvement of 1.1% found in the same fields when winds were assimilated from the QuikScat scatterometer. The impact on tropical cyclone tracks in the forecasts was also studied. The scatterometer improved (reduced) the track errors markedly by 25% in the analyses. When impacts across the forecast range out to five days were also included, the improvement was found to be 8%. In contrast, the assimilation of WindSat data improved the analysis track errors by 7%, although this figure was found to be 10% across the complete forecast range. [J863]

"Target Detection in Single- and Multiple-View Through-the-Wall Radar Imaging"

A detector of targets behind walls and in enclosed structures is presented. The detector is applied to through-the-wall radar images obtained by wideband delay and sum beamforming. We consider the detection problem using single- and multiple-view imaging. The statistics of noise, clutter, and target images are examined and formulated using sample scenes. The effects of wall parameter errors on the image statistics are shown. An iterative detection scheme, which adapts itself to the image statistics, is presented. The proposed detection schemes are evaluated using real data. [J864]

"Chaos UWB Radar for Through-the-Wall Imaging"

In this paper, we propose to apply a novel chaos-based ultra-wide band (UWB) radar for through-the-wall imaging. The proposed chaos modulation offers superior resolution compared to conventional UWB radars when applied for through-the-wall imaging. A noncoherent receiver is designed based on expectation maximization (EM) algorithm. The theoretical detection performance is derived for through-the-wall detection in the presence and absence of room reverberations as a function of dielectric properties of walls, targets, and their geometry illustrating the robustness of the proposed modulation against room reverberations. The resolution of the proposed modulation is analyzed theoretically and verified through simulations for different wall materials. Numerical electromagnetic simulations using finite difference time domain (FDTD) method are performed to confirm the obtained theoretical results. From the theoretical and simulation analysis, we find that the proposed chaos-based pulse amplitude modulated ultra-wide band (CPAM-UWB) radar has better detection performance, penetrating ability and imaging performance compared to other conventional through-the-wall imaging radars. [J865]

"Focusing of Airborne Synthetic Aperture Radar Data From Highly Nonlinear Flight Tracks"

Standard focusing of data from synthetic aperture radar (SAR) assumes a straight recording track of the sensor platform. Small nonlinearities of airborne platform tracks are corrected for during a motion-compensation step while maintaining the assumption of a linear flight path. This paper describes the processing of SAR data acquired from nonlinear tracks, typical of sensors mounted on small aircraft or drones flying at low altitude. Such aircraft do not fly along straight tracks, but the trajectory depends on topography, influences of weather and wind, or the shape of areas of interest such as rivers or traffic routes. Two potential approaches for processing SAR data from such highly nonlinear flight tracks are proposed, namely, a patchwise frequency-domain processing and mosaicking technique and a time-domain back-projection-based technique. Both are evaluated with the help of experimental data featuring tracks with altitude changes, a double bend, a 90deg curve, and a linear flight track. In order to assess the quality of the focused data, close-ups of amplitude images are compared, impulse response functions of a point target are analyzed, and the coherence is evaluated. The experimental data were acquired by the German Aerospace Center's E-SAR L-band system. [J866]

"Multifrequency Continuous-Wave Radar Approach to Ranging in Passive UHF RFID"

In this paper, we present the extension of a recently published two-frequency continuous-wave (CW) ultra-high-frequency RF identification ranging technique to multiple carriers. The proposed system concept relies on exact

phase information; hence, the passive tag cannot be accurately modeled as a frequency-flat linear device. A linearized model of the tag's reflection coefficient is devised to bridge the gap between the nonlinear reality and the linear CW radar theory. Estimation error bounds are derived and effects caused by noise and multipath propagation are analyzed in detail. It has been found that systematic errors introduced by the tag's reflection characteristic cannot be compensated by using multiple carriers due to large variations caused by detuning. Nonetheless the system, while being vulnerable to multipath propagation effects, still performs well under line-of-sight conditions; mean average errors below 15% of the true distance are possible in typical fading environments.. [J867]

"A Time-Series Approach to Estimate Soil Moisture Using Polarimetric Radar Data"

Electromagnetic scattering from a rough surface is a function of both surface roughness and dielectric constant of the scattering surface. Therefore, in order to estimate soil moisture of a bare surface accurately from radar measurements, the effects of surface roughness must be compensated for properly. Several algorithms have been developed to estimate soil moisture from a polarimetric radar image, all with limited ranges of applicability. No theoretical algorithm has been reported to retrieve volumetric soil moisture of a vegetated surface. In this paper, we examine a different approach to estimate soil moisture that exploits the fact that the backscattering cross section from a natural object changes over short timescales mainly due to variations in soil moisture. We develop a model function that expresses copolarized backscattering cross sections (sigmahhand sigmavv) in terms of volumetric soil moisture using L-band experimental data for both bare and vegetated surfaces. In order to estimate soil moisture, two unknowns in the model function must be determined. We propose a viable approach to determine these two unknowns using combined radiometer and radar data. This time-series approach also provides a framework to utilize aprioriknowledge on soil moisture to improve the retrieval accuracy of volumetric soil moisture. We demonstrate that this time-series algorithm is a simple and robust way to estimate soil moisture for both bare and vegetated surfaces. [J868]

"A Waveform Model for Near-Nadir Radar Altimetry Applied to the Cassini Mission to Titan"

The radar altimeter of the Cassini mission to Titan operates in a transition region between pulse- and beam-limited conditions. Due to the specific observation geometry, low values of mispointing angle have been found to significantly affect altimeter impulse response (IR). This involves a nonconventional formulation of the system response which is the main goal of this paper. An analytical model of the average return power waveform, valid for near-nadir altimetry measurements, has been developed in order to cope with the particular operating conditions of Cassini mission. The model used to approximate the altimeter waveform is based on the same general assumptions of the classical Brown's model (1977) but exploits a flat surface response approximation by Prony's methods. Both theoretical considerations and simulated data have been taken into account to support the accuracy of the proposed model. To infer the main geophysical parameters describing surface topography from altimetry data, a parametric estimation procedure has been used. The maximum likelihood estimator procedure has been chosen since, in principle, it can assure optimal performance as a consequence of the analytical model we used to describe the system IR. Performances of the implemented method have been numerically evaluated through simulation of data received by CASSINI in high-resolution altimeter mode. [J869]

"Narrow-Band Interference Suppression for SAR Based on Complex Empirical Mode Decomposition"

Narrow-band interference (NBI) is a common interference source in synthetic aperture radar (SAR) imaging. Its existence will degrade the imaging quality greatly. Based on detailed analysis on the characteristics of NBI, this letter proposes a new NBI suppression algorithm using the complex empirical mode decomposition (CEMD) method. In this algorithm, echoes that include NBI are recognized in the time domain first. Then, these echoes are decomposed into a number of intrinsic mode functions (IMFs) via the CEMD. After that, IMFs that correspond to NBI are subtracted from the echoes by thresholding. Finally, well-focused SAR imagery can be obtained from the separated target echoes using traditional SAR imaging algorithms. The effective data loss in this algorithm is smaller than other NBI suppression approaches. In addition, this algorithm is robust to time-varying NBI. Imaging results of measured data have proved the validity of this algorithm. [J870]

"The European Microwave Week 2008 and Its Microwave Conferences [JTransnational News]"

Under the auspices of the European Microwave Association (EuMA) the 11th annual European Microwave Week was organized in the Amsterdam RAI Congress Centre, The Netherlands, 27-31 October 2008. This major event consisted this year of five conferences, an exhibition, and various side events. The 38th European Microwave Conference (EuMC), the Third European Microwave Integrated Circuits Conference (EuMIC), the Fifth European Radar Conference (EuRAD), and the First European Wireless Technology Conference (EuWiT) were

complemented by the Military Radar Conference 2008. The latter was organized by Defence IQ in London and collocated with the Microwave Week for the fi rst time by invitation of the EuMA and the local organizers. The Military Radar delegates were invited to participate in EuRAD. [J871]

"Characteristic Polarization States Estimation in an Ultrawideband Context: A Frequency Approach"

The concept of characteristic polarization states (CPSs) is extended to an ultrawideband (UWB) context. This is achieved by a sparse representation of the target UWB scattering spectrum by a set of frequency bands associated with the target natural resonance modes. The polarization description involves using the average power within each resonant frequency band to derive the Kennaugh power matrix and, subsequently, a set of CPSs using the Lagrangian optimization procedure. To validate this, preliminary feature sets are formed by extracting robust information from each derived CPS and then implementing a correlation measure criterion from which the relationships between these preliminary feature sets as a function of resonance order are established. These relationships are invariant to range and target orientation about the radar-target direction and are robust to noise. [J872]

"New Concepts for Quasi-Optical Structures for Use With Gyrotron Systems"

This paper discusses the use of some relatively new quasi-optical structures for configuring high-power gyrotron-based millimeter-wave systems for plasma fusion, microwave technologies, electron accelerators, radar, and communication. Techniques for wave combining and switching, and for wave matching to transmitters, receivers, and antennas are analyzed. [J873]

"High-Frequency EM Characterization of Through-Wall Building Imaging"

A high-frequency asymptotic technique based on the Uniform Geometric Theory of Diffraction (UTD) is employed for building interior imaging. The analysis is implemented using a ray-tracing technique to account for multiple scattering interactions in a building, along with a set of heuristic diffraction coefficients for dielectric wedges and corners. Imaging of the synthetic aperture radar data is carried out by the conventional fast Fourier transform method to transform to the downrange domain, and combined with a coherent near-zone imaging function for cross-range. Comparisons with experimental data for a scaled-down building model are given to demonstrate the suitability and efficacy of our analysis for through-wall building imaging. The UTD ray mechanisms account for the dominant scattering features observed in the image. [J874]

"Microfabrication and Characterization of a Selectively Metallized W-Band Meander-Line TWT Circuit"

Vacuum electronic devices offer significant potential for increased power and performance at millimeter-wave frequencies. However, new approaches are required to reliably manufacture the miniature electromagnetic circuits used at these high frequencies. In this paper, we describe the design, fabrication, and testing of an innovative meander-line slow-wave structure for a W-band traveling-wave tube (TWT). The unique challenge of metallizing only the top of a high-aspect-ratio serpentine dielectric ridge using conventionally planar microfabrication techniques is overcome using a novel selective masking and metallization process. The procedure is demonstrated by fabricating a W-band meander-line circuit for a 10-W continuous-wave TWT. Cold-test S-parameter measurements are presented. [J875]

"Direction of arrival estimation for uncorrelated and coherent signals with uniform linear array"

A novel direction of arrival (DOA) estimation method is proposed with uniform linear array when uncorrelated and coherent signals coexist. The DOAs of uncorrelated signals are first estimated using a new method of modified total least squares estimation of signal parameters via rotation invariance techniques. Afterwards, the contributions of uncorrelated signals are eliminated and a new matrix is constructed based on the spatial difference matrix. Then, the coherent signals can be resolved by performing the forward spatial smoothing scheme on the new matrix. The proposed method can resolve more signals than the array elements with good performance. Simulation results demonstrate the effectiveness and efficiency of the proposed method. [J876]

"A Wind and Rain Backscatter Model Derived From AMSR and SeaWinds Data"

The SeaWinds scatterometer was originally designed to measure wind vectors over the ocean by exploiting the relationship between wind-induced surface roughening and the normalized radar backscatter cross section. Rain can degrade scatterometer wind estimation; however, the simultaneous wind/rain (SWR) algorithm was developed to enable SeaWinds to simultaneously retrieve wind and rain rate data. This algorithm is based on colocating data from the Precipitation Radar on the Tropical Rainfall Measuring Mission and SeaWinds on

QuikSCAT. This paper develops a new wind and rain radar backscatter model for SWR using colocated data from the Advanced Microwave Scanning Radiometer (AMSR) and SeaWinds aboard the Advanced Earth Observing Satellite II. This paper accounts for rain height in the model in order to calculate surface rain rate from the integrated rain rate. The performance of SWR using the new wind/rain model is measured by comparison of wind vectors and rain rates to the previous SWR algorithm, AMSR rain rates, and National Center for Environmental Prediction numerical weather prediction winds. The new SWR algorithm produces more accurate rain estimates and improved winds, and detects rain with a low false alarm rate. [J877]

"Chirp-Scaling Algorithm for Bistatic SAR Data in the Constant-Offset Configuration"

This paper discusses the processing method for bistatic SAR data in the constant-offset configuration. The constant-offset configuration is also known as the azimuth stationary or invariant configuration where transmitter and receiver follow each other, moving on identical velocity vector. In this paper, the proposed processing method for bistatic SAR data is based on Loffeld's bistatic formula that consists of two terms, i.e., the quasi-monostatic (QM) term and bistatic-deformation (BD) term. Our basic idea is to linearize the aforementioned two terms and then incorporate the BD term into the QM term to obtain an analogous monostatic spectrum. Based on the new spectrum, any efficient 2-D frequency or range-Doppler domain processor can easily be employed to process the bistatic data, where the Doppler phase parameters of the processor need to be adjusted. In this paper, we concentrate on the application of chirp-scaling-algorithm (CSA) processor. In addition, a bistatic-motion error model is developed where the position deviations of the two platforms are simplified as the bistatic slant-range displacement in the zero Doppler plane. Using this model, the monostatic motion-compensation technique is applied and integrated into CSA to compensate the trajectory deviations of transmitter and receiver. Finally, real and simulated data are used to validate the proposed processing method. [J878]

"Surface-Based Polarimetric C-Band Microwave Scatterometer Measurements of Snow During a Chinook Event"

This paper presents a case study of C-band backscatter observations of snow during a Chinook event. A surface-based C-band polarimetric data set collected in February 2006 is used to contrast the polarimetric response to sampled conditions of bare frozen ground, cold snow-covered ground, and snow during a Chinook event. Chinook activity is inherently spatially and temporally variable across the region in winter and produces considerable spatial variability of snow-cover physical properties associated with snow-water-equivalent (SWE) estimates. A temporal analysis of polarimetric backscatter sensed during a Chinook-induced ablation event on February 27, 2006 is used to describe the associated changes in snow conditions and scattering mechanisms. Analysis reveals that the polarimetric surface-based C-band scatterometer data respond to changes in snow parameters associated with the specific ground and snow conditions and to the temporal Chinook ablation event. Use of the copolarizations, cross-polarization, depolarization ratio, copolarization ratio, complex copolarization correlation coefficient, and the copolarized phase difference information show promise in describing changes in snow physical parameters, differing ground and snow conditions, and transitional ablation events, based on differing scattering mechanisms. This paper infers that an increase in volume scattering and fluctuations in surface scattering during the Chinook ablation event may be associated with specific physical changes such as density, crystal structure, and permittivity caused by wind speed. This paper has implications for remotely sensed estimations of snow-covered area (SCA) and SWE. Association of SCA and SWE with backscatter coefficients is not explicit in this paper; however, changes in SWE and snow properties are inferentially linked to changes in backscatter. [J879]

"The GPS Contribution to the Error Budget of Surface Elevations Derived From Airborne LIDAR"

When using airborne LIDAR to produce digital elevation models, the global positioning system (GPS) positioning of the LIDAR instrument is often the limiting factor, with accuracies typically quoted as being 10-30 cm. However, a comprehensive analysis of the accuracy and precision of GPS positioning of aircraft over large temporal and spatial scales is lacking from the literature. Here, an assessment is made of the likely GPS contribution to the airborne LIDAR measurement error budget by analyzing more than 500 days of continuous GPS data over a range of baseline lengths (3-960 km) and elevation differences (400-2000 m). Height errors corresponding to the 95th percentile are <0.15 m when using algorithms commonly applied in commercial software over 3-km baselines. These errors increase to 0.25 m at 45 km and <0.5 m at 250 km. At aircraft altitudes, relative heights are shown to be potentially biased by additional errors approaching 0.2 m, partly due to unmodeled tropospheric zenith total delay (ZTD). The application of advanced algorithms, including parameterization of the residual ZTD, gives error budgets that are largely constant despite baseline length and elevation differences. In this case, height errors corresponding to the 95th percentile are <0.22 m out to 960 km, and similar levels are shown for one randomly chosen day over a 2300-km baseline. [J880]

"On-Chip Voltage Reference-Based Time-to-Digital Converter for Pulsed Time-of-Flight Laser Radar Measurements"

A fully integrated time-to-digital converter (TDC) for a pulsed time-of-flight laser rangefinder has been designed and fabricated by a standard 0.18-mum CMOS process. The time-to-digital conversion is realized by counting the full clock cycles of an on-chip ring oscillator between timing signals and by recording the state of its 12 phases at the moment of arrival of the timing signals and their delayed replicas. The frequency of the oscillator is stabilized to an on-chip voltage reference by means of a frequency-to-voltage-converter-based feedback loop. The resolution and single-shot precision (standard deviation) of the TDC are ~ 60 ps and less than ~ 50 ps, respectively, in a range of 80 ns. The worst-case temperature dependence of the TDC is less than 50 ppm/degC in the temperature range of 0 degC to 70 degC, corresponding to 0.6 mm/degC at a distance of 12 m (80 ns). The power consumption of the TDC is less than 18 mW. [J881]

"Unambiguous Reconstruction and High-Resolution Imaging for Multiple-Channel SAR and Airborne Experiment Results"

Azimuth ambiguity occurs in synthetic aperture radar (SAR) systems due to the well-known constraint of minimum antenna area, particularly at high resolutions and wide swaths. A space time domain method can be utilized to remove this ambiguity if the multiple-channel data are available. In this letter, a modified approach is presented to determine the filter weight vectors. This approach was successfully applied to the real data, which were collected by an experimental airborne multiple-channel SAR system. The channel imbalance and the error in antenna phase center position are analyzed in detail. [J882]

"Detection and Discrimination of Land Mines in Ground-Penetrating Radar Based on Edge Histogram Descriptors and a Possibilistic -Nearest Neighbor Classifier"

This paper describes an algorithm for land mine detection using sensor data generated by a ground-penetrating radar (GPR) system that uses edge histogram descriptors for feature extraction and a possibilistic K-nearest neighbors (K-NNs) rule for confidence assignment. The algorithm demonstrated the best performance among several high-performance algorithms in extensive testing on a large real-world datasets associated with the difficult problem of land mine detection. The superior performance of the algorithm is attributed to the use of the possibilistic K-NN algorithm, thereby providing important evidence supporting the use of possibilistic methods in real-world applications. The GPR produces a 3-D array of intensity values, representing a volume below the surface of the ground. First, a computationally inexpensive prescreening algorithm for anomaly detection is used to focus attention and identify candidate signatures that resemble mines. The identified regions of interest are processed further by a feature extraction algorithm to capture their salient features. We use translation-invariant features that are based on the local edge distribution of the 3-D GPR signatures. Specifically, each 3-D signature is divided into subsignatures, and the local edge distribution for each subsignature is represented by a histogram. Next, the training signatures are clustered to identify prototypes. The main idea is to identify few prototypes that can capture the variations of the signatures within each class. These variations could be due to different mine types, different soil conditions, different weather conditions, etc. Fuzzy memberships are assigned to these representatives to capture their degree of sharing among the mines and false alarm classes. Finally, a possibilistic K-NN-based rule is used to assign a confidence value to distinguish true detections from false alarms. The proposed algorithm is implemented and integrated within a complete-- land mine prototype system. It is trained, field-tested, evaluated, and compared using a large-scale cross-validation experiment that uses a diverse dataset acquired from four outdoor test sites at different geographic locations. This collection covers over 41 807 m2of ground and includes 1593 mine encounters. [J883]

"An Adaptive and Fast CFAR Algorithm Based on Automatic Censoring for Target Detection in High-Resolution SAR Images"

An adaptive and fast constant false alarm rate (CFAR) algorithm based on automatic censoring (AC) is proposed for target detection in high-resolution synthetic aperture radar (SAR) images. First, an adaptive global threshold is selected to obtain an index matrix which labels whether each pixel of the image is a potential target pixel or not. Second, by using the index matrix, the clutter environment can be determined adaptively to prescreen the clutter pixels in the sliding window used for detecting. The G0distribution, which can model multilook SAR images within an extensive range of degree of homogeneity, is adopted as the statistical model of clutter in this paper. With the introduction of AC, the proposed algorithm gains good CFAR detection performance for homogeneous regions, clutter edge, and multitarget situations. Meanwhile, the corresponding fast algorithm greatly reduces the computational load. Finally, target clustering is implemented to obtain more accurate target regions. According to the theoretical performance analysis and the experiment results of typical real SAR images, the proposed algorithm is shown to be of good performance and strong practicability. [J884]

"Estimation of the Surface Velocity Field of the Aletsch Glacier Using Multibaseline Airborne SAR Interferometry"

This paper presents a methodology to process airborne interferometric synthetic aperture radar (SAR) data to measure surface velocity fields (SVFs) of temperate glaciers, and applies it to data acquired over the Aletsch glacier. The first part of this paper deals with the main limitation in airborne interferometric SAR to retrieve reliable interferometric products, namely, the existence of the so-called residual motion errors-inaccuracies on the order of a few centimeters in the navigation system. An extended multisquint approach is proposed for their estimation in the case of nonstationary scenes. The second part of this paper expounds an efficient methodology to derive SVFs with airborne systems, where the line-of-sight displacement is estimated using differential interferometry and the along-track component by estimating the azimuth coregistration offsets. The necessary steps to finally obtain the 3-D SVF are also presented, as well as the possibility of combining different acquisition geometries. Airborne interferometric SAR data acquired by the Experimental SAR system of the German aerospace center over the Aletsch glacier, located in the Swiss Alps, are used to evaluate the performance of the proposed approach. The motion of the corner reflectors deployed in the scene is retrieved with an accuracy between 1 and 5 cm/day using L-band data. [J885]

"Analysis by Wavelet Frames of Spatial Statistics in SAR Data for Characterizing Structural Properties of Forests"

Spatial statistics (texture) in SAR backscatter data of forested areas bears information on structural and geometric properties that could be useful in mapping forest extent, species type, and stages of regeneration or degradation. Based on a previously published theoretical approach in deriving texture measures from SAR data using wavelet frames, experiments are reported that aim to characterize, from a purely observational point of view, wavelet texture measures' sensitivity with respect to target structural properties and SAR configurations. Suitable analytical tools are introduced to represent dependences in the combined space-scale-polarization domain through signatures that condense information in graphical form. Moreover, class separability, afforded by wavelet texture measures in a supervised classification setting and based on the Fischer linear discriminant analysis, is considered. This paper focuses on two structurally different forest types (tropical rain forest in the Central Africa Congo Floodplain and mixed-species wooded savanna in Queensland, Australia) and uses data from orbital radars, particularly from the Japanese Advanced Land Observing Satellite Phased Arrayed L-band Synthetic Aperture Radar. The analysis indicated that textural information from spatial statistics can provide, in some cases, better class separability in forest mapping with respect to one-point statistics, although spatial resolution in texture products is reduced. However, dependences of texture measures on the polarization state are detected, particularly in forests where a greater diversity of scattering mechanisms occurs. [J886]

"Cassini Radar Data: Estimation of Titan's Lake Features by Means of a Bayesian Inversion Algorithm"

The analysis derived from the Cassini SAR imagery reflects the complex Titan's surface morphology with a wide range of backscattering coefficients and peculiar features such as periodic structures and lakelike features, which were observed on July 22, 2006, when polar areas were first imaged, and are considered good candidates to be filled with liquid hydrocarbons. In this paper, the modeling description of lakes is addressed by means of a double-layer model which considers an upper liquid-hydrocarbon layer and a lower layer compatible with the radar response of the neighboring areas. This model is introduced into a Bayesian framework for the purpose of inferring the likely ranges of some parameters and, in particular, of the optical thickness of the hypothesized liquid-hydrocarbon layer and of the wind speed. The main idea is to use the information contained in the parameter probability density function, which describes how probability is distributed among the different values of parameters according to the various scenarios considered. The analysis carried out on lakes and surrounding areas on flybys T16 and T19 determines optical thickness values from 0.2 to 6. For T25 flyby, the inferred values of optical thickness indicate that a limit value of optical thickness may be 9. Considering that, beyond these values, the signal from the bottom layer is completely attenuated, information on the wind speed on the upper layer can be inferred. The found mean values of wind speed are around 0.2-0.3 m/s according to different hypotheses on the upper layer dielectric constant. [J887]

"Analysis of Eccentered Dipole Antenna for Borehole Radar"

A dipole antenna in a borehole may be placed away from the center of the borehole, and this eccentricity produces additional complicated electromagnetic fields, which may influence borehole radar signals. In this paper, we analyze an eccentric dipole antenna in a borehole for borehole radars. Our approach is an extended version of the pseudoanalytical formulation that was previously applied for analyzing an induction logging tool

and a dielectric logging tool. The proposed equations are suitable for modeling the finite dipole antenna, utilizing a method-of-moments. The eccentricity of the radar sonde has two consequences. First, it modifies the antenna characteristics such as its impedance, and second, it changes the electromagnetic field inside the borehole, owing to the change of the structure of the cylindrical layers. These two changes are evaluated by the proposed algorithm and two types of experiments. The first one is a measurement of the input impedance of a monopole antenna which is in cylindrical layers on a ground plane in air. The second one is about the transmission between two antennas, one of which is eccentered in cylindrical layers. This experiment was done in granite at a field test site and on a ground plane in air. In the field experiments, we controlled the position of the radar sonde in a borehole and made the antenna eccentered artificially. We found that a 4- cm displacement resulted in changes of 4 dB in amplitude and 4 ns in time delay. Comparing the experimental and calculated data obtained by the present method shows the validity of the proposed analytical formulation. [J888]

"Implementation of SDR Digital Beamformer for Microsatellite SAR"

The hardware reconfiguration feature of a software-defined radio (SDR) architecture can support multiple modes of a digital beamformer (DBF) striving for compactness and efficient processing power, which are important issues for microsatellite synthetic aperture radar (SAR) systems. In this letter, based on the SDR architecture, a DBF system, consisting of multiple beam, direction-of-arrival (DOA) estimation, and null-steering operation modes, is realized using a field-programmable gate array (FPGA) processor. Since the hardware reconfiguration has to be processed with minimal delay, the FPGA hardware must be of modularized design. Different modes can share the common module during mode switching. Experimental results verify the performance of DOA, null steering, and mode switching. The processing time of each DBF mode is less than the cross-range pulse repetition interval of the microsatellite SAR system. [J889]

"Improved Photonic Technique for Broadband Radio-Frequency Measurement"

We propose a photonic technique for the measurement of frequency information in radar signal processing applications that has the potential to cover a frequency range of 40 GHz. This technique compares the radio-frequency power response functions generated within a low dispersion element of two complementary double sideband optical signals. The technique eliminates measurement ambiguities over the entire operating range along with reduced sensitivity to dispersion errors. The scheme is experimentally demonstrated over the frequency range of 4-19 GHz. [J890]

"Suitability and Limitations of ENVISAT ASAR for Monitoring Small Reservoirs in a Semiarid Area"

In semiarid regions, thousands of small reservoirs provide the rural population with water, but their storage volumes and hydrological impact are largely unknown. This paper analyzes the suitability of weather-independent radar satellite images for monitoring small reservoir surfaces. The surface areas of three reservoirs were extracted from 21 of 22 ENVISAT Advanced Synthetic Aperture Radar scenes, acquired bimonthly from June 2005 to August 2006. The reservoir surface areas were determined with a quasi-manual classification approach, as stringent classification rules often failed due to the spatial and temporal variability of the backscatter from the water. The land-water contrast is critical for the detection of water bodies. Additionally, wind has a significant impact on the classification results and affects the water surface and the backscattered radar signal (Bragg scattering) above a wind speed threshold of 2.6 mmiddots-1. The analysis of 15 months of wind speed data shows that, on 96% of the days, wind speeds were below the Bragg scattering criterion at the time of night time acquisitions, as opposed to 50% during the morning acquisition time. Night time acquisitions are strongly advisable over day time acquisitions due to lower wind interference. Over the year, radar images are most affected by wind during the onset of the rainy season (May and June). We conclude that radar and optical systems are complimentary. Radar is suitable during the rainy season but is affected by wind and lack of vegetation context during the dry season. [J891]

"A Support-Vector-Machine-Based Approach to RF Sensor Spectral Signature Classifications"

In this paper, a support vector machine (SVM) classifier was designed to identify tornado vortices based on their characteristics that were determined from the Doppler spectra and eigenvalues that were calculated from the data that were collected in the vicinity of these vortices. To collect these data, weather surveillance radar (WSR-88D) was employed, which is locally operated by the National Severe Storms Laboratory (NSSL) on the north campus of the University of Oklahoma, Norman. This particular radar, which is devoted to experimental research rather than operational weather forecasting, has the unique capability of recording massive volumes of in-phase (I) and quadrature (Q) data over many hours. As such, the received radar echo power and Doppler shift information can be determined from these I and Q complex-valued data, which provides a rich environment for evaluating our new postprocessing algorithms. At the current time, most radar systems, including North

America's national network of weather radar systems, process these I and Q data in real time to produce environmental measurements known as ldquospectral moments,rdquo which are the first three statistical moments of the data. These three moments (the reflectivity, the radial velocity, and the spectrum width) are then provided to scientists or forecasters, and the abundance of I and Q data is not preserved to save computer resources. One of the aims of this paper is to show how additional information about the atmosphere can be garnered from the I and Q data. To assist this mission, an SVM-based classifier evades the pitfalls of the traditional statistical learning algorithms, such as neural networks, by setting up a convex optimization problem with a single global minimum. In addition, through the use of kernels and a nonlinear mapping to higher dimensional spaces, the SVM classifier is able to effectively handle nonlinear classification problems. The idea behind this transformation is to facilitate the-- separability of classes by taking the input vectors to a higher dimensional space. The SVM classifier has the added advantage of reducing overfitting by constructing a maximum margin to separate hyperplanes in a higher dimensional feature space to ensure a small generalization error bound. Finally, our practical results are in positive agreement with our theoretical predictions. [J892]

"Large Margin Feature Weighting Method via Linear Programming"

The problem of feature selection is a difficult combinatorial task in machine learning and of high practical relevance. In this paper, we consider feature selection method for multimodally distributed data, and present a large margin feature weighting method for k-nearest neighbor (kNN) classifiers. The method learns the feature weighting factors by minimizing a cost function, which aims at separating different classes by large local margins and pulling closer together points from the same class, based on using as few features as possible. The consequent optimization problem can be efficiently solved by linear programming. Finally, the proposed approach is assessed through a series of experiments with UCI and microarray data sets, as well as a more specific and challenging task, namely, radar high-resolution range profiles (HRRP) automatic target recognition (ATR). The experimental results demonstrate the effectiveness of the proposed algorithms. [J893]

"Data Flow and Workflow Organization-The Data Management for the TerraSAR-X Payload Ground Segment"

The payload ground segment (PGS) for the recently launched German radar satellite, TerraSAR-X, performs the operational data management of the acquired satellite data. This comprises well-known functions such as reception, systematic and on-demand processing, archiving and cataloguing, ordering, and dissemination of digital Earth-observation products. In addition, it comprises new functions like large-scale multimode acquisition ordering by users, integration with a commercial service segment, and new interfaces and workflows within the complete ground segment. The TerraSAR-X PGS is based on the Data Information and Management System (DIMS), the multimission data-handling infrastructure of the German Remote Sensing Data Center (DFD) at the German Aerospace Center. The development and integration of the new functions and complex workflows for TerraSAR-X were achieved and successfully tested on time. After the support of commissioning phase for five months, the system is now operational. As an intended side effect, the PGS for TerraSAR-X is, in several aspects, a pattern being reused for upcoming future missions, thus substantially reducing overall developmental costs. This paper investigates features of the TerraSAR-X PGS that enable the reuse in a multimission environment. It summarizes the achieved enhancements and extensions of DIMS to support the TerraSAR-X mission. Special emphasis is placed on the implementation of the request workflow initiated by user orders and the corresponding data flow within the distributed DFD multimission facility. [J894]

"Polarimetric Differential SAR Interferometry: First Results With Ground-Based Measurements"

The Remote Sensing Laboratory of the Universitat Politecnica de Catalunya carried out a one-year measuring campaign in the village of Sallent, northeastern Spain, using a polarimetric ground-based synthetic aperture radar (SAR) sensor. The objective was to study the subsidence phenomenon induced by the salt mining activity conducted in this area up to the middle of the last century. Zero-Baseline polarimetric SAR (PolSAR) data were gathered at X-band in nine different days, from June 2006 to March 2007. In this letter, the problem of extracting subsidence information from fully PolSAR acquisitions for the retrieval of high-quality deformation maps is addressed. After compensating for the atmospheric artifacts caused by troposphere changes, the linear component of the deformation process is estimated separately for each polarization channel with the Coherent Pixels Technique (CPT). Afterward, a novel polarimetric approach mixing the differential-phase information of each polarization channel is proposed. The results obtained in the two cases are quantitatively compared, and the advantages provided by the polarimetric acquisitions are finally stressed. [J895]

"Speckle Suppression in SAR Images Using the 2-D GARCH Model"

A novel Bayesian-based speckle suppression method for Synthetic Aperture Radar (SAR) images is presented

that preserves the structural features and textural information of the scene. First, the logarithmic transform of the original image is analyzed into the multiscale wavelet domain. We show that the wavelet coefficients of SAR images have significantly non-Gaussian statistics that are best described by the 2-D GARCH model. By using the 2-D GARCH model on the wavelet coefficients, we are capable of taking into account important characteristics of wavelet coefficients, such as heavy tailed marginal distribution and the dependencies between the coefficients. Furthermore, we use a maximum a posteriori (MAP) estimator for estimating the clean image wavelet coefficients. Finally, we compare our proposed method with various speckle suppression methods applied on synthetic and actual SAR images and we verify the performance improvement in utilizing the new strategy. [J896]

"DOA estimation for ULA by spectral Capon rooting method"

A direction of arrival (DOA) estimation method based on the spectral Capon rooting algorithm is developed. The developed method realises DOA estimation by real polynomial rooting technique rather than a grid search. It provides a lower computation complexity and a better performance compared to the spectral Capon searching algorithm. Simulation results demonstrate the effectiveness of the method. [J897]

"Experimental results on ISAR imaging with stepped-frequency waveforms"

A simple and successful processing for the bandwidth synthetic of stepped-frequency waveforms (SFWs) is presented. The high range resolution is obtained by combining the sub-pulses of SFWs in the frequency domain. The overlapping bandwidth of the two adjacent sub-pulses is used to estimate phase errors. Also the usual motion compensation approach is avoided if the band coherent processing is used. Experimental results of the ship target are shown. [J898]

"Low profile Salisbury screen radar absorber with high impedance ground plane"

The radar absorbing properties of a Salisbury screen are investigated for a structure which is constructed using a high impedance ground plane. Simulated and experimental results in the frequency band 8-12 GHz show that this physical arrangement can be used to obtain a significant reduction in the physical thickness of the absorber when the specified -10 dB reflectivity bandwidth is in the range 18-37%. [J899]

"Mathematical modelling and performance analysis for average-based rapid search method for direct global position system precision code acquisition"

Direct global position system precision code acquisition is desirable for providing stronger anti-jamming and anti-spoofing capabilities than the handover from a coarse acquisition code. Because of the high chip rate and long period of the precision code (P-code), direct acquisition is challenging. By averaging incoming and local signals respectively, to reduce the number of code phases to be searched, previously proposed direct and overlap average methods provide an efficient way to rapid acquisition. To further analyse the performance of average methods the previously proposed direct and overlap average methods are generalised, the corresponding mathematical modelling is established, the correlation properties of the averaged P-code are studied and the detection and mean acquisition time performances are investigated. By increasing the weighting of the local signal, which has a code phase shift in samples of half of the average length, improved overlap average methods are proposed. Compared with the previously proposed direct and overlap average methods, the improved overlap average methods have better detection performance and can further improve acquisition performance, that is, shorten the mean acquisition time. Numerical results demonstrate the enhancement. [J900]

"Foundation for mitigating range dependence in radar space-time adaptive processing"

The problem of detecting slow-moving targets using a space-time adaptive processing (STAP) radar is addressed. The determination of the optimum interference-rejection weights at each range is based on snapshots at neighbouring ranges. However, in virtually all bistatic configurations or/and when using conformal antenna arrays (CAA), snapshot statistics are range dependent, which results in poor detection performance. To address this issue, a foundation for range-dependence compensation in STAP in the case of Gaussian interference and noise is proposed. The realistic case where received snapshots are the only source of information for mitigating the range dependence is considered. To illustrate the usefulness of the proposed foundation, this foundation is used to design a method to adaptively compensate for range dependence in a challenging situation, that is, for a radar using a CAA and operating in a bistatic configuration. [J901]

"Analysis of global navigation satellite system position deviation under spoofing"

The position deviation in global navigation satellite system (GNSS) positioning, which is subject to spoofing, is

analysed. A spoofer transmits GNSS-like signals to a navigation receiver and may cause a significant position deviation in navigation computation. Although GNSS receivers can be equipped with certain receiver autonomous integrity monitoring (RAIM) schemes to provide fault detection and isolation functions, it is possible that the misleading information because of spoofers may enter a GNSS receiver without being detected. As spoofers may inject erroneous pseudo-range measurements to the navigation receiver with a false message, it is important to assess the spoofing effect on the resulting position. An optimisation approach is adopted to determine the worst-case misleading message and the resulting position deviation. A vulnerability index against spoofing is defined for the assessment of the position deviation in a spoofed environment. [J902]

"Radix- Resolution-Fusion for LASAR via Orthogonal Complement Decomposition"

This letter concerns the resolution-fusion method for linear array 3-D imaging SAR (LASAR). Limited by the length of the linear array, the cross-track resolution of LASAR is often lower than that in the along-track direction. To overcome this disadvantage, we assume that there are two LASAR systems whose trajectories are orthogonal to each other. Thus, we obtain a row low-resolution image and a column low-resolution image of the same scene. Using the orthogonal complement decomposition technique, we fuse the two images into one quasi-high-resolution image. Moreover, we find that the fusion distortion is unavoidable and contains the high-frequency component in both row and column directions. The information loss ratio is (N- 1)2/N2(Ndenotes the ratio of low resolution to high resolution). For a smooth image, the energy loss ratio is near to zero. With the increase of the noise energy, the energy loss ratio increases correspondingly. When the noise submerges the image completely, the energy loss ratio converges to the information loss ratio. [J903]

"A Novel Method of Distance Measurement Based on Pulse Position Modulation and Synchronization of Chaotic Signals Using Ultrasonic Radar Systems"

This paper deals with a novel method of transmission and receipt of a signal based on both the property of two chaotic systems generating the same chaotic signal when they are synchronized and the property of pulse position modulation (PPM) to be insensitive to the distortions of the transmission channel. The method is discussed in the context of ultrasonic radar systems, in which the transmitter and receiver, which consist of ultrasonic sensors, are near each other, and the received signal consists of the transmitted signal reflected by an obstacle. A reference sinusoidal signal is superimposed to a chaotic signal generated by a master chaotic system, and the whole signal is modulated according to the PPM method and transmitted by the sensor. The received signal is demodulated, and the demodulated signal forces a slave chaotic system to generate the chaotic signal embedded in it, which allows recovery of the sinusoidal signal by subtracting this chaotic signal from the demodulated echo. The difference of the phases of the reference sinusoidal signal and the recovered sinusoidal signal allows computation of the timeofflightof the signal and, consequently, the distance of the radar system from the obstacle. The novel method is illustrated and tested by both simulation and experiments. The interference problem between the considered radar system and other radar systems (crosstalk) is also addressed, and a solution is proposed to avoid it. [J904]

"New ISAR imaging algorithm based on modified Wigner-Ville distribution"

Inverse synthetic aperture radar (ISAR) imaging of air, space or ship targets with complex motion has attracted the attention of many researchers in the past decade. Complex motion of targets induce cross-range scatterer-variant quadratic phase terms, which will degrade the cross-range resolution and affect focusing quality. A new algorithm is proposed for the ISAR imaging of complex moving targets. First, conventional range alignment, phase compensation and range compression are performed over the raw phase history data such that each range bin can be modelled as the sum of several linear frequency modulation or chirp signals. Secondly, a modified-Wigner-Ville distribution (referred to as M-WVD) approach is proposed, which is based on a scale transform in the time-frequency distribution plane and can effectively suppress the troublesome cross-term interference associated with WVD via coherent integration. Finally, the azimuth ISAR image can be obtained via a simple maximisation projection from the two-dimensional accumulated plot to the azimuth dimension. Compared with existing WVD-based ISAR imaging algorithms, the proposed method has the following features: better cross-term interference reduction achieved at no resolution loss, computationally more efficient with no expensive two-dimensional parameter search, and higher signal processing gain because of coherent integration during the whole imaging time. Both numerical and experimental results are provided to demonstrate the performance of the proposed method. [J905]

"Statistical analysis of the zero-phase method for aligning noisy high-resolution radar signals"

Automatic target recognition using high-range resolution radars is a difficult task. Variations in the distance to the target cause circular shifts of the received signal, and most of the classification algorithms are very sensitive to

shifts over the input signal. This fact makes the alignment of each signal prior to any classification stage very important. Here the alignment of noisy signals using the zero phase method is studied. In order to evaluate the performance of the alignment method, a theoretical analysis of the sensitivity to noise of this alignment method is carried out. As a result, an analytical expression that predicts the error of the alignment method is obtained. The validity of this expression is also confirmed by experimental results. A database of high-range resolution radar profiles containing patterns belonging to six different targets has been used, and a comparative study of the sensitivity to noise estimated using the profiles of the database and predicted by the analytical expression is carried out. The results demonstrate that the proposed analytical expression is useful to analyse the sensitivity to noise of the zero-phase alignment method for medium and high signal-to-noise ratio values. [J906]

"Improvement of high-frequency surface waves radar performances by use of multiple-input multiple-output configurations"

A multiple-input multiple-output (MIMO) configuration has been studied for communication applications, offering a lot of advantages to mitigate propagation effects because of multipath and fading environments. More recently, MIMO techniques in radar have been proposed. MIMO is discussed in the context of high-frequency surface waves radar (HFSWR). After a short introduction to the MIMO radar technique (a technique which is not new; the RIAS developed by ONERA was probably the first MIMO radar), explores two different applications are explored. The first application aims at improving the resolution and accuracy of a coastal radar, proposed here in a bistatic configuration. Such a radar operates with a wide sparse frequency band and with an equivalent wide aperture, taking advantage of the MIMO configuration. Simulation over a congested area of targets demonstrates the benefit of MIMO over the conventional HFSWR radar, especially in terms of separation of targets. The second application consists in a more practical ship-borne HFWSR configuration compatible with space time adaptive processing (STAP) to improve the detection of slow targets. In this case, a limited number of receiving channels is considered whereas STAP uses the degrees of freedom offered by the transmitting array. The MIMO-STAP is compared with a conventional STAP, showing that theoretical performances should not be affected by the MIMO configuration even if the signals are no longer perfectly orthogonal, because of Doppler shift, once scattered by moving targets. [J907]

"Exploiting SAR and VHR Optical Images to Quantify Damage Caused by the 2003 Bam Earthquake"

Using satellite sensors to detect urban damage and other surface changes due to earthquakes is gaining increasing interest. Optical images at different resolutions and radar images represent useful tools for this application, particularly when more frequent revisit times will be available with the implementation of new missions and future possible constellations of satellites. Very high resolution (VHR) images (on the order of 1 m or less) may provide information at the scale of a single building, whereas images at resolutions on the order of tens of meters may give indications of damage levels at a district scale. Both types of information may be extremely important if provided with sufficient timeliness to rescue teams. The earthquake that hit the city of Bam, Iran, has been taken as a test case, where QuickBird VHR optical images and advanced synthetic aperture radar data were available both before and after the event. Methods to process these data in order to detect damage and to extract features used to estimate damage levels are investigated in this paper, pointing out the significant potential of these satellite data and their possible synergy. [J908]

"Hierarchical Feature-Based Classification Approach for Fast and User-Interactive SAR Image Interpretation"

The framework of this paper is focused on semiautomatic fast recognition of areas of interest for fast and user-interactive synthetic aperture radar (SAR) image interpretation for which only a unique intensity SAR image is available. The goal is to label regions into classes significant to a given application in an image, as rapidly as possible. A semiautomated ldquoroughrdquo classification is proposed. It defines the information extraction as a two-level procedure. The technique is based on a first partition image into homogeneous regions using the approach proposed by Galland Then, discrimination characteristics are determined in each homogeneous region. This allows one to automatically obtain a first segmentation of the image into semantic regions of interest. Finally, this segmentation can be easily modified by a user in a limited computational time. At this level, they are considered as ldquoobjects,rdquo to identify which typical class of ground it can be attached to. Among a large set of tested measures, we have selected the most pertinent ones for the considered SAR images. In fact, we will see that to obtain an accurate measures estimation, measures need to be estimated inside a neighborhood as homogeneously as possible. This can be achieved with a reasonable confidence in the proposed approach due to the homogeneity properties of the segmentation technique applied. In this paper, we focus on linear structures, urban structures, agricultural parcels, and forest areas extraction in SAR images. [J909]

"On the Reduction of the Systematic Error in Imaging Radiometry by Aperture Synthesis: A New Approach for the SMOS Space Mission"

The Soil Moisture and Ocean Salinity (SMOS) mission is a European Space Agency project aimed at global monitoring of surface SMOS from radiometric L-band observations. This letter is concerned with the reduction of the systematic error (or bias) in the reconstruction of radiometric brightness temperature maps from SMOS interferometric measurements. A recent and efficient method has been proposed for reducing this error. However, a residual bias still persists. A new approach for reducing this bias down to residual values less than 0.1 K is presented here and illustrated with numerical simulations. [J910]

"Effects of Birefringence Within Ice Sheets on Obliquely Propagating Radio Waves"

In this paper, effects of birefringence on radio waves obliquely propagating though polar ice sheets are examined to facilitate interpretations of bistatic and side-looking radar data. A formalism applicable for arbitrary radar configurations is developed to predict the returned power from within and beneath the ice sheets that have arbitrary alignments of ice crystals (ice fabrics). We applied this formalism to a range of ice fabrics found in ice cores and assessed the effects of birefringence in terms of ray-path configurations, ice fabrics, and radar frequency. Predicted frequency dependence of the bed return power replicates prominent features observed at Greenland NGRIP ice-core site. Results show that birefringence in ice of 1 km or more thickness with strong (weak) fabric can reduce the power returned from the bed 2 dB or more at frequencies higher than 200 MHz (20 MHz) as compared to isotropic ice. This suggests that quantitative interpretation of the power returned from the bed requires careful assessment of birefringence almost everywhere over the ice sheets. Application of this formalism also suggests a radar-frequency range usable for attenuation measurements, possible effects of fabric on synthetic aperture radar processing, and a feasibility of remote sensing of ice fabric. [J911]

"LMMSE 3-D SAR Focusing"

Three-dimensional synthetic aperture radar (SAR) imaging, a technique also known as SAR tomography, uses multiple views to extend the capability of SAR systems to 3-D imaging by achieving a profiling of the scattering power at different heights. Multiple views are obtained with the current satellite technology via successive passes of a single antenna SAR sensor over the same scene, but next-generation sensor formations are foreseen to acquire multistatic data. Conventional processing, such as the beamforming, or singular values decomposition inversion is based on geometrical derivations and, hence, assumes the accurate phase calibration and the absence of target decorrelation. This paper analyzes the effects of phase miscalibration due to residual uncompensated atmospheric contribution and temporal decorrelation and proposes a 3-D imaging technique based on a linear minimum mean square error approach. The resulting algorithm extends the possibilities of the conventional processing by carrying out an integration of data that accounts for the aprioridata correlation properties. Hence, it allows handling of the presence of additional stochastic contributions such as: temporal coherence losses and atmospheric phase miscalibration. Moreover, with reference to future bistatic and multistatic systems, it permits an improved coherent integration of data acquired by simultaneous antenna in repeated passes. [J912]

"Four-Dimensional SAR Imaging for Height Estimation and Monitoring of Single and Double Scatterers"

The superposition of contributions from different stable targets within the same pixel is a phenomenon that may impair the imaging and monitoring of ground scatterers via the multipass synthetic aperture radar (SAR) interferometry technique. Three-dimensional SAR imaging, also known as SAR tomography, uses multiple views to profile the scattering power at different heights. This technique has been shown to be capable of separating interfering target responses on real data. Differential SAR tomography has been recently proposed as a technique that extends the potentialities of SAR tomography to the target deformation monitoring. It performs a 4-D space-velocity imaging that enables not only separating interfering targets in elevation but also distinguishing their single slow deformation velocities. This work addresses for the first time the application of 4-D SAR imaging to real data to determine the height and mean deformation velocity of single scatterers and double-scattering mechanisms interfering at high resolution in the same pixel. It also discusses the postprocessing steps required to identify the presence of stable single and double scatterers after elevation-velocity focusing. Moreover, it proposes a technique for the extraction of time series from interfering targets to measure possible nonlinear temporal deformations. [J913]

"A Novel Definition and Measurement Method of Group Delay and Its Application"

The time synchronization accuracy demanded in satellite navigation systems, deep space exploration, and

spread spectrum radar has reached the subnanosecond range. The phase distortion induced by RF cables, amplifiers, and mixers affects the spread spectrum signal delay and causes dominant error in time synchronization. To measure and calibrate the influence of phase distortion, it is necessary to devise a high-accuracy group delay measurement method and study its relationship with signal delay. The traditional definition and measurement formula of group delay is based on the derivative, which has some inherent faults such as inconsistency of resolution and accuracy, incapacity to describe the global phase character of signal bandwidth, and difficulty in establishing a relationship with spread spectrum signal delay. To overcome such shortcomings, a novel group delay definition and measurement formula has been put forward based on Taylor series expansion, which has been used in Global Positioning System timing receiver RF cable group delay measurement. The experiment showed that the accuracy of the new group delay measurement was better than 0.01 ns and was very consistent with the signal delay. The maximum bias between the signal delay and the zeroth-order group delay was less than 0.3 ns. [J914]

"Optimum Data Vector Approach to Multibaseline SAR Interferometry Phase Unwrapping"

Phase unwrapping is a key problem not only in all quantitative applications of synthetic aperture radar (SAR) interferometry but also in other fields. In this letter, a new phase unwrapping approach is investigated. Our study is based on the model of the optimum data vector. In order to autocoregister the SAR images, the proposed method takes advantage of the multibaseline optimal weighted joint data vector by extracting all the coherence information available in the neighboring pixels. Moreover, the method employs the projection of the joint signal subspace onto the corresponding noise subspace to estimate the unwrapped interferometric phases (or the terrain heights). The proposed method can accurately determine the dimensions of the noise subspace and provide the robust unwrapped interferometric phases even in the presence of the large image coregistration errors. Moreover, the multibaseline processing idea is a combination of data optimization, image coregistration, interferogram filtering, and phase unwrapping. [J915]

"Design of Phase Codes for Radar Performance Optimization With a Similarity Constraint"

This paper deals with the design of coded waveforms which optimize radar performances in the presence of colored Gaussian disturbance. We focus on the class of phase coded pulse trains and determine the radar code which approximately maximizes the detection performance under a similarity constraint with a prefixed radar code. This is tantamount to forcing a similarity between the ambiguity functions of the devised waveform and of the pulse train encoded with the prefixed sequence. We consider the cases of both continuous and finite phase alphabet, and formulate the code design in terms of a nonconvex, NP-hard quadratic optimization problem. In order to approximate the optimal solutions, we propose techniques (with polynomial computational complexity) based on the method of semidefinite program (SDP) relaxation and randomization. Moreover, we also derive approximation bounds yielding a ldquomeasure of goodnessrdquo of the devised algorithms. At the analysis stage, we assess the performance of the new encoding techniques both in terms of detection performance and ambiguity function, under different choices for the similarity parameter. We also show that the new algorithms achieve an accurate approximation of the optimal solution with a modest number of randomizations. [J916]

"Optimal Polarized Beampattern Synthesis Using a Vector Antenna Array"

Using polarized waveforms increases the capacity of communication systems and improves the performance of active sensing systems such as radar. We consider the optimal synthesis of a directional beam with full polarization control using an array of electromagnetic vector antennas (EMVA). In such an array, each antenna consists of pges 2 orthogonal electric or magnetic dipole elements. The control of polarization and spatial power patterns is achieved through carefully designing the amplitudes and phases of the weights of these dipole antennas. We formulate the problem in a convex form, which is thus efficiently solvable by existing solvers such as the interior point method. Our results indicate that vector antenna arrays not only enable full polarization control of the beampattern, but also improve the power gain of the main beam (over the sidelobes), where the gain is shown numerically to be linearly proportional to vector antenna dimensionality p. This implies that EMVA not only offers the freedom to control the beampattern polarization, but also virtually increases the array size by exploiting the full electromagnetic (EM) field components. We also study the effect of polarization on the spatial power pattern. Our analysis shows that for arrays consisting of pairs of electrical and magnetic dipoles, the spatial power pattern is independent of the mainbeam polarization constraint. [J917]

"On the Relationship Between MIMO and SIMO Radars"

This correspondence explores the close relationship between multiple-input multiple-output (MIMO), single-input multiple-output (SIMO), and phased-array radars. It is shown that under certain conditions, the signals received by a MIMO radar and by a properly defined SIMO radar are identical. Several equivalent variations of MIMO and

SIMO radars are presented. These relationships make it possible to study MIMO radars in terms of their equivalent SIMO radars, using the extensive body of algorithms and performance analysis which have been developed for SIMO radars. [J918]

"Adaptive Detection and Estimation in the Presence of Useful Signal and Interference Mismatches"

This paper considers adaptive detection and estimation in the presence of useful signal and interference mismatches. We assume a homogeneous environment where the random disturbance components from the primary and secondary data share the same covariance matrix. Moreover, the data under test contains a deterministic interference vector in addition to the possible useful signal. We focus on the situation where an energy fraction of both the useful signal and the deterministic interference may lie outside their nominal subspaces (conical uncertainty model). Under these conditions, we devise a procedure for the computation of the joint maximum likelihood (ML) estimators of the useful signal and interference vectors, resorting to a suitable rank-one decomposition of a semidefinite program (SDP) problem optimal solution. Hence, we use the aforementioned estimators for the synthesis of adaptive receivers based on different generalized likelihood ratio test (GLRT) criteria. At the analysis stage, we assess the performance of the new detectors in comparison with some decision rules, available in open literature. [J919]

"CMP Antenna Array GPR and Signal-to-Clutter Ratio Improvement"

Ground-penetrating radar (GPR) is recognized as a promising sensor for detecting buried landmines. In this case, the GPR antenna(s) must be elevated above the ground. However, this requirement results in heavy surface clutter. It is therefore necessary to overcome the effect. A commonly used procedure of time gating and background averaging cannot suit to small shallow nonmetallic landmine beneath a rough ground surface. In this letter, we proposed techniques to enhance the target signal through common midpoint (CMP) antenna array and data processing techniques, including velocity spectrum and CMP multifold stacking. The method has been tested using experiment data over a rough ground under which small plastic antipersonnel landmines is shallowly buried. The result shows the signal-to-clutter ratio was dramatically improved. [J920]

"Singular Unit Restoration in Interferograms Based on Complex-Valued Markov Random Field Model for Phase Unwrapping"

In generating a digital elevation map from an interferogram obtained by interferometric synthetic aperture radar, the filtering process is as important as the phase unwrapping process. Before unwrapping, we usually have to restore the data image by reducing so-called singular points (SPs) by filtering process without destroying or smearing delicate fringes. Previously, an effective SP restoration method was proposed based on the complex-valued Markov random field (CMRF) model. However, there is still room for improvement in the definition of SPs and in the formulation of CMRF parameter estimation. In this letter, we propose a novel scheme by introducing a new concept, namely, the ldquosingular unit.rdquo We also estimate CMRF parameters locally as a weighted sum by taking the distance and SP numbers in sample sites into account. By using this restoration method, we demonstrate a high-performance removal of SPs. We also find that delicate landscape features, which are often lost in conventional filtering, are preserved appropriately. We confirm the quality in higher signal-to-noise ratios obtained against actual height data. [J921]

"A Novel Approach to Range Doppler SAR Processing Based on Legendre Orthogonal Polynomials"

The range Doppler algorithm (RDA) is based on Taylor series expansion for the transfer function (TF) phase component, resulting in increasing phase error as the range frequency or the squint angle increases. We introduce Legendre orthogonal polynomials into synthetic aperture radar data processing steps to replace Taylor series expansion used in approximating the TF phase. A novel range Doppler imaging approach based on Legendre expansion is addressed with an extended RDA as example, and the analytical expressions of the new phase multiplication factors are then derived. The simulation results show that the proposed method provides better focusing performance than the conventional RDA in the same squint case and is more suitable for the large squint mode while there is negligible increment of computation load. [J922]

"Comparison of Compact Polarimetric Synthetic Aperture Radar Modes"

Compact polarimetry is a technique that allows construction of pseudo quad-pol information from dual-polarization synthetic aperture radar (SAR) systems. Compact polarimetry showed promise of being able to reduce the complexity, cost, mass, and data rate of a SAR system while attempting to maintain many capabilities of a fully polarimetric system. In this paper, we study different transmit/receive configurations to determine which

polarimetric configurations allow for superior reconstruction of the fully polarimetric data. We discuss modifications of the original reconstruction algorithm proposed by Souyris, which show potential to better reconstruct fully polarimetric data. [J923]

"Variability of Passive Microwave Radiometric Signatures at Different Spatial Resolutions and Its Implication for Rainfall Estimation"

Analysis of precipitation radar (PR) and Tropical Rainfall Measuring Mission (TRMM) microwave imager (TMI) data collected from the TRMM satellite shows that rainfall inhomogeneity, as represented by the coefficient of variation (CV), depends on a spatial scale, i.e., the CV appears to be nearly constant at all rain rates within the field of view (FOV) of the TMI 37-GHz channel, while it decreases with rain rate at lower spatial resolutions, such as the FOV sizes of the low-frequency TMI channels (10.7 and 19.4 GHz). It is known that the brightness temperature (Tb) for a low-frequency channel decreases with increasing rainfall inhomogeneity for a given rain rate. As such, more inhomogeneous rainfall at low rain rates leads to a lower Tbcompared with that of a FOV with homogeneous rainfall; however, less inhomogeneous rainfall at high rain rates tends to produce a Tbsimilar to that of homogeneous rainfalls. These results indicate that the observed radiometric signatures of low-frequency channels at low spatial resolutions are characterized by a larger response range and smaller variability than those at a higher spatial resolution. Based on the observational characteristics of the TMI and PR data sets, we performed synthetic retrievals of rainfalls, employing a Bayesian retrieval methodology at different retrieval resolutions corresponding to the FOV sizes of the TMI channels at 10.7, 19.4, and 37 GHz. Comparisons of the rainfalls retrieved at the different resolutions and their temporal and regional averages show that the systematic bias resulting from the rainfall inhomogeneity is smaller in the lower resolution data than in their higher resolution counterparts. We note that such low-resolution rainfall retrievals are not expected to describe the instantaneous features of rain fields; however, they could be useful for climatological estimates at large temporal and spatial scales. [J924]

"Installation of a Doppler Radar Monitoring System at Merapi Volcano, Indonesia"

Merapi Volcano, Indonesia, is one of the most active dome building volcanoes worldwide. Instabilities at the growing dome cause rockfalls and hot block and ash flows, which can reach run-out distances of several kilometers. Therefore, Merapi has been monitored extensively for many years. However, direct visual observation of the dome is often impossible due to cloud coverage of the summit. In October 2001, a first prototype Doppler radar system was installed to overcome this shortcoming. The system is able to penetrate clouds and observe material movements at the dome, giving valuable information about dynamic processes in the dome area. The system also allows detection of rainfall in several distance intervals. For precise positioning of the beam, the system was equipped with an electromechanical mounting in 2003. A charge-coupled device (CCD) camera attached to the radar mirror documents the radar beam position and provides visual observation of the dome. Recorded data, camera images, and status information are telemetered to the Merapi Volcano Observatory, where they can be processed and interpreted. Status information is also sent via short message service via a global system for mobile communications (GSM) modem. By processing the Doppler radar data, we are able to discriminate between three different types of instability events: sliding dome material, dome material gravitationally breaking off the dome, and explosive outbursts of dome material due to expansion of volcanic gas. In order to independently verify our observations, we compared rockfall events detected by the radar system to seismic recordings and found a good correlation. [J925]

"Measurement of Ionospheric Faraday Rotation in Simulated and Real Spaceborne SAR Data"

The influence of the atmosphere on a frequency-modulated electromagnetic wave traversing the ionosphere is becoming increasingly important for recent and upcoming low-frequency and wide-bandwidth spaceborne synthetic aperture radar (SAR) systems. The ionized ionosphere induces Faraday rotation (FR) at these frequencies that affects radar polarimetry and causes signal path delays resulting in a reduced range resolution. The work at hand introduces a simulation model of SAR signals passing through the atmosphere, including both frequency-dependent FR and path delays. Based on simulation results from this model [proven with real Advanced Land Observing Satellite Phased Array L-band Synthetic Aperture Radar (PALSAR) data], estimation of FR in quad-polarized SAR data using the given approach is shown for raw, range-compressed, and focused radar images. Path delays and signal chirp bandwidth effects are considered. Investigations discuss the suitability of raw and compressed data versus combination of total electron content maps with the Earth's magnetic field for FR estimation and deduced from a large number of analyzed PALSAR data sets. [J926]

"A Numerical Study of the Retrieval of Sea Surface Height Profiles From Low Grazing Angle Radar Data"

A numerical study of the retrieval of sea surface height profiles from low grazing angle radar observations is described. The study is based on a numerical method for electromagnetic scattering from 1-D rough sea profiles, combined with the ldquoimproved linear representationrdquo of Creamer for simulating weakly nonlinear sea surface hydrodynamics. Numerical computations are performed for frequencies from 2975 to 3025 MHz so that simulated radar pulse returns are achieved. The geometry utilized models a radar with an antenna height of 14 m, observing the sea surface at ranges from 520 to 1720 m. The low grazing angles of this configuration produce significant shadowing of the sea surface, and standard analytical theories of sea scattering are not directly applicable. Three approaches for retrieving sea height profile information are compared. The first method uses a statistical relationship between the surface height and the computed radar cross sections versus range (an incoherent measurement). A second method uses the phase difference between scattering measurements in two vertically separated antennas (ldquovertical interferometry) in the retrieval. The final technique retrieves height profiles from variations in the apparent Doppler frequency (coherent measurements) versus range and requires that time-stepped simulations be performed. The relative advantages and disadvantages of each of the three approaches are examined and discussed. [J927]

"Time-Reversal Detection Using Antenna Arrays"

The paper studies detection of a target buried in a rich scattering medium by time reversal. We use a multi-static configuration with receive and transmit arrays of antennas. In time reversal, the backscattered field is recorded, time reversed, and retransmitted (mathematically or physically) into the same scattering medium. We derive two array detectors: the time-reversal channel matched filter when the target channel response is known; and the time-reversal generalized-likelihood ratio test (TR-GLRT) when the target channel response is unknown. The noise added in the initial probing step to the time-reversal signal makes the analysis of the TR-GLRT detector non trivial. The paper derives closed form expressions for the signal-to-noise ratio gain provided by this detector over the corresponding conventional clutter subtraction energy detector in the two extreme conditions of weak and strong (electronic additive) noise and shows that time reversal provides, under weak noise, the optimal waveform shape to probe the environment. We analyze the impact of the array configuration on the detection performance. Finally, experiments with electromagnetic data collected in a multipath scattering laboratory environment confirm our analytical results. Under the realistic conditions tested, time reversal provides detection gains over conventional detection that range from 2 to 4.7 dB. [J928]

"Enhanced SAR-Based Snow-Covered Area Estimation Method for Boreal Forest Zone"

In this paper, an enhanced method for fractional snow-covered area (SCA) estimation for the boreal forest zone is presented. The new approach, based on utilizing weather station data alongside with spaceborne synthetic aperture radar (SAR) imagery, leads to a significantly improved estimation accuracy. While the Helsinki University of Technology (TKK) SAR-based SCA estimation method serves as a basic tool in the SCA estimation, the ground-based weather station observations are employed to still strengthen its performance at the nearly melt-off or totally melt-off conditions. The method is still improved by a new reference image selection process, leading to more accurate results and an easier adaptivity to new areas. The SCA estimation accuracy of the new enhanced method is compared with optical satellite-based SCA data. Evaluation of the method is carried out using Radarsat wide-swath data for the snow-melt seasons of 2004-2006. The results show a significant increase in accuracy when the enhanced SCA method is applied. Correlation between the radar-based and optical comparison data increases from 0.914 to 0.947 and root-mean-square error improves from 0.151 to 0.123 with the new method. Traditionally, the TKK method has provided SCA estimates for Finnish third-order subdrainage basins. In this paper, the method is adapted to produce SCA estimates also in 5 times 5 km spatial resolution. The analyses for the 5 times 5 km method indicate poorer estimation accuracy than the nominal drainage-basin-based method. [J929]

"Through-the-Wall Surveillance With Millimeter-Wave LFMCW Radars"

The use of millimeter-wave radars allows a weight and size reduction of circuits and antennas, which is an important characteristic for Through-the-Wall Surveillance (TWS) applications. Furthermore, when using the millimeter-wave band, a large amount of bandwidth can be easily transmitted, given that the relative bandwidth is smaller. This leads to a high range resolution that allows for the discrimination of several targets that are very close in range, e.g., inside a room. The azimuth resolution is also improved due to the availability in this band of directive antennas with small dimensions. This paper studies the feasibility of using a millimeter-wave linear frequency-modulated continuous-wave radar in a TWS application. A TWS experiment in a real scenario has been done to demonstrate the validity of the theoretical analysis. [J930]

"On the Use of Auxiliary Receive Channels for Clutter Mitigation With Phased Array Weather Radars"

Phased array radars (PARs) are attractive in weather surveillance primarily because of their capability to electronically steer. When combined with the recently developed beam multiplexing (BMX) technique, these radars can obtain very rapid update scans that are useful in monitoring severe weather. A consequence is that the small number of contiguous samples of the time series obtained can be a challenge for temporal/spectral filters used for clutter mitigation. As a result, the accurate extraction of weather signals can become the limiting performance barrier for PARs that employ BMX in clutter-dominated scattering fields. By exploiting the spatial correlation of the auxiliary channel signals, the effect of clutter contamination can be reduced in these conditions. In this paper, three spatial filtering techniques that used low-gain auxiliary receive channels are presented. The effect of clutter mitigation was studied using numerical simulations of a tornadic environment for changes in signal-to-noise ratio, clutter-to-signal ratio, number of time series samples, varying clutter spectral widths, and maximum weight constraints. Since such data are not currently available from a horizontally pointed phased array weather radar, experimental validation was applied to an existing data set from the turbulent eddy profiler, which is a vertically pointed PAR. Although preliminary, the results show promise for clutter mitigation with extremely short nonuniform sampling. [J931]

"Performance of Stereoradargrammetric Methods Applied to Spaceborne Monostatic-Bistatic Synthetic Aperture Radar"

This paper aims to investigate the performance of stereoradargrammetric methods applied to spaceborne monostatic-bistatic synthetic aperture radar (SAR) data for digital elevation model (DEM) generation. Stereoradargrammetric techniques for robust DEM generation were successfully experienced on monostatic repeat-pass SIR-A, SIR-B, SIR-C/X-SAR, ERS1/2, JERS-1, and Radarsat data. However, novel configurations achievable by modern spacecraft flying in formation will allow for the attainment of very large baselines between the antennas in a single-pass bistatic geometry so that the height determination accuracy can benefit from both stereo effect and simultaneous acquisition. Five models for relief reconstruction by monostatic-bistatic SAR stereoradargrammetry are presented, and an error budget is assessed for each of them. Results of the sensitivity analysis exhibit metric accuracy, and therefore, the technique could be applied for height reconstruction as a methodology complementary to SAR interferometry. [J932]

"Omega-k Algorithm for Airborne Spatial Invariant Bistatic Spotlight SAR Imaging"

Bistatic spotlight synthetic aperture radar (SAR) which uses a separated transmitter and receiver has been studied intensively due to its flexibility. To reconstruct the image for the bistatic SAR in the parallel track configuration, where the transmitter and the receiver have equal velocity, we modify the omega-k algorithm. Specifically, using the extended Taylor approximation (ETA), we convert the parallel track configuration into the single track configuration. Then, using the principle of the stationary phase, we propose an analytical method to increase the image quality of bistatic SAR systems. [J933]

"DEM Reconstruction Accuracy in Multichannel SAR Interferometry"

Interferometric synthetic aperture radar (InSAR) systems allow the estimation of the height profile of the Earth surface. When the height profile of the observed scene is characterized by high slopes or exhibits strong height discontinuities, the height reconstruction obtained from a single interferogram is ambiguous, since the solution of the estimation problem is not unique. To solve this ambiguity and restore the solution uniqueness, multiple interferograms, obtained with different baselines and/or with different frequencies, have to be used (multichannel InSAR). The height profile can then be estimated from multiple interferograms using maximum likelihood (ML) estimation techniques or by means of maximum aposteriori(MAP) estimation techniques, which take into account the relation between adjacent pixels. In this paper, the height estimation accuracy achievable with a given multibaseline interferometric configuration and using the aforementioned estimation techniques in terms of Cramer-Rao lower bound for the ML and of error lower bound for the MAP, is analyzed and discussed. It is shown that the MAP technique outperforms the ML one and that its attainable accuracy is not sensitive to the baselines choice, while mainly depends on the ground slopes. [J934]

"Radiometric Calibration of LIDAR Intensity With Commercially Available Reference Targets"

We present a new approach for radiometric calibration of light detection and ranging (LIDAR) intensity data and demonstrate an application of this method to natural targets. The method is based on 1) using commercially available sand and gravel as reference targets and 2) the calibration of these reference targets in the laboratory conditions to know their backscatter properties. We have investigated the target properties crucial for accurate and consistent reflectance calibration and present a set of ideal targets easily available for calibration purposes. The first results from LIDAR-based brightness measurement of grass and sand show that the gravel-based calibration approach works in practice, is cost effective, and produces statistically meaningful results:

Comparison of results from two separate airborne laser scanning campaigns shows that the relative calibration produces repeatable reflectance values. [J935]

"Brightness-Temperature Retrieval Methods in Synthetic Aperture Radiometers"

Brightness-temperature retrieval techniques for synthetic aperture radiometers are reviewed. Three different approaches to combine measured visibility and antenna temperatures, along with instrument characterization data, into a general equation to invert are presented. Discretization and windowing techniques are briefly discussed, and formulas for reciprocal grids using rectangular and hexagonal samplings are given. Two known techniques are used to invert the equation, namely, inverse Fourier transform and G-matrix pseudoinverse. The proposed preprocessing approaches combined with these two inversion methods are implemented with real data measured by an airborne Y-shaped interferometric radiometer over land and water, and are compared. The images indicate that best results are obtained when inverting an incremental visibility obtained after substracting a term that includes the individual antenna temperatures, the physical temperatures of the receivers, and a flat-target response directly measured from cold-sky looks. [J936]

"Range-Doppler Imaging Via a Train of Probing Pulses"

We consider range-Doppler imaging via transmitting a train of probing pulses. We present two methods for range-Doppler imaging. The first one is based on the instrumental variables (IV) filter and the second one is based on the iterative adaptive approach (IAA). Numerical results show that both methods can suppress interference from neighboring range and Doppler bins. An attractive feature of the IV filter is that it can be computed offline. IAA has better performance than IV and has super resolution, but at the cost of a higher computational complexity. [J937]

"Improved Sigma Filter for Speckle Filtering of SAR Imagery"

The Lee sigma filter was developed in 1983 based on the simple concept of two-sigma probability, and it was reasonably effective in speckle filtering. However, deficiencies were discovered in producing biased estimation and in blurring and depressing strong reflected targets. The advancement of synthetic aperture radar (SAR) technology with high-resolution data of large dimensions demands better and efficient speckle filtering algorithms. In this paper, we extend and improve the Lee sigma filter by eliminating these deficiencies. The bias problem is solved by redefining the sigma range based on the speckle probability density functions. To mitigate the problems of blurring and depressing strong reflective scatterers, a target signature preservation technique is developed. In addition, we incorporate the minimum-mean-square-error estimator for adaptive speckle reduction. Simulated SAR data are used to quantitatively evaluate the characteristics of this improved sigma filter and to validate its effectiveness. The proposed algorithm is applied to spaceborne and airborne SAR data to demonstrate its overall speckle filtering characteristics as compared with other algorithms. This improved sigma filter remains simple in concept and is computationally efficient but without the deficiencies of the original Lee sigma filter. [J938]

"Potential of Estimating Soil Moisture Under Vegetation Cover by Means of PolSAR"

In this paper, the potential of using polarimetric SAR (PolSAR) acquisitions for the estimation of volumetric soil moisture under agricultural vegetation is investigated. Soil-moisture estimation by means of SAR is a topic that is intensively investigated but yet not solved satisfactorily. The key problem is the presence of vegetation cover which biases soil-moisture estimates. In this paper, we discuss the problem of soil-moisture estimation in the presence of agricultural vegetation by means of L-band PolSAR images. SAR polarimetry allows the decomposition of the scattering signature into canonical scattering components and their quantification. We discuss simple canonical models for surface, dihedral, and vegetation scattering and use them to model and interpret scattering processes. The performance and modifications of the individual scattering components are discussed. The obtained surface and dihedral components are then used to retrieve surface soil moisture. The investigations cover, for the first time, the whole vegetation-growing period for three crop types using SAR data and ground measurements acquired in the frame of the AgriSAR campaign. [J939]

"Tropical-Forest-Parameter Estimation by Means of Pol-InSAR: The INDREX-II Campaign"

This paper addresses the potential and limitations of polarimetric synthetic aperture radar (SAR) interferometry (Pol-InSAR) inversion techniques for quantitative forest-parameter estimation in tropical forests by making use of the unique data set acquired in the frame of the second Indonesian Airborne Radar Experiment (INDREX-II) campaign-including Pol-InSAR, light detection and ranging (LIDAR), and ground measurements-over typical Southeast Asia forest formations. The performance of Pol-InSAR inversion is not only assessed primarily at L- and P-band but also at higher frequencies, namely, X-band. critical performance parameters such as the

ldquovisibility of the groundrdquo at L- and P-band as well as temporal decorrelation in short-time repeat-pass interferometry are discussed and quantitatively assessed. Inversion performance is validated against LIDAR and ground measurements over different test sites. [J940]

"Using a Ground-Based SAR Interferometer and a Terrestrial Laser Scanner to Monitor a Snow-Covered Slope: Results From an Experimental Data Collection in Tyrol (Austria)"

In this paper, we report on an experimental activity aimed at investigating the potential of two terrestrial remote-sensing techniques, namely, ground-based SAR (GB SAR) interferometry and terrestrial laser scanning, in order to retrieve snow-depth (SD) measurements in mountainous regions. Terrestrial laser scanning is a more consolidated technique based on the measurement of the optical (near infrared) reflectivity, and it is affected by the surface of the snow layer: a temporal data sequence allows us to estimate the absolute SD variation. Recent use of SAR interferometry to evaluate snow-mass characteristics is based on relating the measured interferometric phase shift to a change in the snow mass. Interferometric GB SAR measurements and terrestrial laser scanner scans were collected together with pointwise conventional measurements of physical snow parameters during the winters of 2005/2006 and 2006/2007. The experiment was carried out in the Wattener Lizum, a high Alpine area at about 2000-m elevation north of the main ridge of the Austrian Alps in Tyrol. Notwithstanding the difficulty of providing both lengthy data record in dry snow conditions and detailed knowledge of the observed snow characteristics, the obtained results confirmed the presence of a clearly measurable interferometric phase variation in relation to the growing height of the snow layer. A comparison of the SD maps obtained through the two techniques shows differences partly due to the different nature of the two observations. [J941]

"Automatic Model-Based Estimation of Boreal Forest Stem Volume From Repeat Pass C-band InSAR Coherence"

C-band repeat pass interferometric synthetic aperture radar coherence can provide high-accuracy estimates of boreal forest stem volume in spite of environmental dependence. Typically, the retrieval methods require a data set of insitumeasurements for training the model linking coherence to stem volume. The drawback is the need for such data and the incapacity to take into account spatial variations of environmental conditions. Here, we demonstrate a model training method that does not require reference data. For the investigated case, the relative root mean square error of stem volume is 18% or as good as obtained using the traditional training method with insitudata. [J942]

"Waveform Libraries"

Our goal was to provide an overview of a circle of emerging ideas in the area of waveform scheduling for active radar. Principled scheduling of waveforms in radar and other active sensing modalities is motivated by the nonexistence of any single waveform that is ideal for all situations encountered in typical operational scenarios. This raises the possibility of achieving operationally significant performance gains through closed-loop waveform scheduling. In principle, the waveform transmitted in each epoch should be optimized with respect to a metric of desired performance using all information available from prior measurements in conjunction with models of scenario dynamics. In practice, the operational tempo of the system may preclude such on-the-fly waveform design, though further research into fast adaption of waveforms could possibly attenuate such obstacles in the future. The focus in this article has been on the use of predesigned libraries of waveforms from which the scheduler can select in lieu of undertaking a real-time design. Despite promising results, such as the performance gains shown in the tracking example presented here, many challenges remain to be addressed to bring the power of waveform scheduling to the level of maturity needed to manifest major impact as a standard component of civilian and military radar systems. [J943]

"Waveform-Agile Sensing and Processing [JFrom the Guest Editors]"

The focus of this special issue is the development of signal processing techniques that are able to take full advantage of advances in radar systems. Phased array radars and space-time adaptive processing illuminate the value of waveform diversity with respect to time, space, frequency, and polarization. [J944]

"Water Level Estimation and Reduction of Hydraulic Model Calibration Uncertainties Using Satellite SAR Images of Floods"

Exploitation of river inundation satellite images, particularly for operational applications, is mostly restricted to flood extent mapping. However, there lies significant potential for improvement in a 3-D characterization of floods (i.e., flood depth maps) and an integration of the remote-sensing-derived (RSD) characteristics in hydraulic

models. This paper aims at developing synthetic aperture radar (SAR) image analysis methods that go beyond flood extent mapping to assess the potential of these images in the spatiotemporal characterization of flood events. To meet this aim, two research issues were addressed. The first issue relates to water level estimation. The proposed method, which is an adaptation to SAR images of the method developed for water level estimation using flood aerial photographs, is composed of three steps: (1) extraction of flood extent limits that are relevant for water level estimation; (2) water level estimation by merging relevant limits with a Digital Elevation Model; and (3) constraining of the water level estimates using hydraulic coherence concepts. Applied to an ENVISAT image of an Alzette River flood (2003, Grand Duchy of Luxembourg), this provides plusmn54-cm average vertical uncertainty water levels that were validated using a sample of ground surveyed high water marks. The second issue aims at better constraining hydraulic models using these RSD water levels. To meet this aim, a "traditional" calibration using recorded hydrographs is completed via comparison between simulated and RSD water levels. This integration of the RSD characteristics proves to better constrain the model (i.e., the number of parameter sets providing acceptable results with respect to observations has been reduced). Furthermore, simulations of a flood event of a different return period (2007) using the model calibrated for the 2003 flood event shows the reliability of the latter for flood forecasting. [J945]

"Foreword to the Special Issue on Retrieval of Bio- and Geophysical Parameters From SAR Data for Land Applications"

This IEEE Transactions on Geoscience and Remote Sensing (TGRS) special issue is dedicated to the advances in synthetic aperture radar (SAR) techniques and applications presented at the 5th International Symposium on Retrieval of Bio- and Geophysical Parameters from SAR Data for Land Applications (BioGeoSAR), which was organized by Consiglio Nazionale delle Ricerche, with active support from the European Space Agency, and held in Bari, Italy, on September 25-28, 2007. The purpose of the symposium has been to provide a forum for researchers to review current trends in the field of retrieval of quantitative information from SAR data and to present and discuss new ideas and new research directions. The BioGeoSAR symposia are usually held every three years in Europe with worldwide participation. [J946]

"Distinguished Tutorials Program"

{no data available} [J947]

"Radar image processing with clusters of computers"

Some radar image processing algorithms such as shape-from-shading are particularly compute-intensive and time-consuming. If, in addition, a data set to be processed is large, then it may make sense to perform the processing of images on multiple workstations or parallel processing systems. We have implemented shape-from-shading, stereo matching, resampling, gridding, and visualization of terrain models in such a manner that they execute either on parallel machines or on clusters of workstations. We were motivated by the large image data set from NASA's Magellan mission to planet Venus, but received additional inspiration from the European Union's Center for Earth Observation program (CEO) and Austria's MISSION initiative for distributed processing of remote sensing images on remote workstations, using publicly-accessible algorithms. We developed a multi-processor approach that we denote as CDIP for Concurrent and Distributed Image Processing. The speedup for image processing tasks increases nearly linearly with the number of processors, be they on a parallel machine or arranged in a cluster of distributed workstations. Our approach adds benefits for users of complex image processing algorithms: the efforts for code porting and code maintenance are reduced and the necessity for specialized parallel processing hardware is eliminated. [J948]

"Pulsed 1.5- m LIDAR for Axial Aircraft Wake Vortex Detection Based on High-Brightness Large-Core Fiber Amplifier"

In this paper, we present the development of an axial aircraft wake vortex light detection and ranging (LIDAR) sensor, working in Mie scattering regime, based on pulsed 1.5-mu m high-brightness large-core fiber amplifier. An end-to-end Doppler heterodyne LIDAR simulator is used for the LIDAR design. The simulation includes the observation geometry, the wake vortex velocity image, the scanning pattern, the LIDAR instrument, the wind turbulence outside the vortex, and the signal processing. An innovative high-brightness pulsed 1.5-mum laser source is described, based on a master oscillator power fiber amplifier (MOPFA) architecture with a large-core fiber. The obtained beam quality is excellent (M2= 1.3), and achieved pulsed energy is 120 muJ with a pulse repetition frequency of 12 kHz and a pulse duration of 800 ns. A Doppler heterodyne LIDAR is developed based on this laser source with a high-isolation free-space circulator. The LIDAR includes a real-time display of the wind field. Wind dispersion is postprocessed. Field tests carried out at Orly airport in April 2008 are reported. Axial aircraft wake vortex signatures have been successfully observed and acquired at a range of 1.2 km with

axial resolution of 75 m for the first time with fiber laser source. [J949]

"Interferometry by Deconvolution of Multicomponent Multioffset GPR Data"

Interferometric techniques are now well known to retrieve data between two receivers by the cross correlation of the data recorded by these receivers. Cross-correlation methods for interferometry rely mostly on the assumption that the medium is loss free and that the sources are all around the receivers. A recently developed method introduced interferometry by deconvolution that is insensitive to loss mechanisms by principle and requires sources only on one side of the receivers. In this paper, we develop such method for ground-penetrating radar, illustrate the concept, and discuss implications for practical applications with numerical examples. [J950]

"Using ENVISAT ASAR Global Mode Data for Surface Soil Moisture Retrieval Over Oklahoma, USA"

The Advanced Synthetic Aperture Radar (ASAR) onboard of the satellite ENVISAT can be operated in global monitoring (GM) mode. ASAR GM mode has delivered the first global multiyear C-band backscatter data set in HH polarization at a spatial resolution of 1 km. This paper investigates if ASAR GM can be used for retrieving soil moisture using a change detection approach over large regions. A method previously developed for the European Remote Sensing (ERS) scatterometer is adapted for use with ASAR GM and tested over Oklahoma, USA. The ASAR-GM-derived relative soil moisture index is compared to 50-km ERS soil moisture data and pointlike insitumeasurements from the Oklahoma MESONET. Even though the scale gap from ASAR GM to the insitumeasurements is less pronounced than in the case of the ERS scatterometer, the correlation for ASAR against the insitumeasurements is, in general, somewhat weaker than for the ERS scatterometer. The analysis suggests that this is mainly due to the much higher noise level of ASAR GM compared to the ERS scatterometer. Therefore, some spatial averaging to 3-10 km is recommended to reduce the noise of the ASAR GM soil moisture images. Nevertheless, the study demonstrates that ASAR GM allows resolving spatial details in the soil moisture patterns not observable in the ERS scatterometer measurements while still retaining the basic capability of the ERS scatterometer to capture temporal trends over large areas. [J951]

"Using Altimetry Waveform Data and Ancillary Information From SRTM, Landsat, and MODIS to Retrieve River Characteristics"

In this paper, spaceborne radar altimeters are shown to have the potential for monitoring the height of large rivers with accuracies of approximately 1 m. However, the need for a better height accuracy and the observations of smaller continental basins have led to studies on how to improve and extend the use of nadir-altimeter data. Conventional retracking techniques over land are limited to the examination of altimeter waveforms on a case-by-case basis. Due to the arbitrary geometry which may be present at altimeter river crossings, this approach may be limited to large rivers, which approximate ocean crossings. To overcome this limitation, we introduce a waveform-fitting method which uses the entire set of waveforms associated with a water crossing, rather than individual waveforms. By using ancillary data, such as digital elevation model (obtained from Shuttle Radar Topography Mission and Gtopo30) and classification maps (obtained from Landsat and MODIS), it is possible to recast the retracking problems as a maximum-likelihood-estimation problem. Theoretical power returns based on the a priori knowledge of the observed scenes are generated, resulting in a parametric library of waveform histories, which is then used to constrain the estimation. For demonstration, we concentrate on the river Meuse in northern western Europe and on the river Lena in Russia. The Meuse has important social impact, since it has flooded in the past and better real-time predictions of its changing stage may improve flood-forecasting skill. Furthermore, it presents a challenge to conventional nadir-altimeter waveform retracking. We will present both theoretical performance results and demonstrate the feasibility based on real altimeter data. [J952]

"C-Band Scatterometer Measurements of Multiyear Sea Ice Before Fall Freeze-Up in the Canadian Arctic"

Backscatter signatures of multiyear sea ice (MYI) during the late summer and early fall season before the fall freeze-up in the Canadian Arctic archipelago (CAA) have been obtained through the use of a ship-based polarimetric scatterometer. The device operates in C-band, and measurements were conducted in swaths from incidence angles of 20 deg-60deg. Three characteristic sites on MYI floes were investigated in the high Arctic and the central Arctic regions. Insitusnow and sea-ice thermophysical data were collected at each site in conjunction with local scatterometer measurements. The thermophysical data were subsequently analyzed using dielectric modeling techniques and coupled with the backscattering measurements (sigmadeg). Observed backscatter values and ratios were found to be in agreement with literature data, with volumetric scattering as the dominant scattering mechanism. [J953]

"Phase-Coded Waveforms and Their Design"

The design of radar waveforms has received considerable attention since the 1950s. In 1953, P.M. Woodward (1953; 1953) defined the narrowband radar ambiguity function or, simply, ambiguity function. It is a device formulated to describe the effects of range and Doppler on matched filter receivers. Woodward acknowledged the influence that Shannon's communication theory from 1948 had on his ideas; and he explained the relevance of ambiguity in radar signal processing, perhaps best conceived in terms of a form of the uncertainty principle (see the sections "Motivation" and "Ambiguity Functions"). However, in the 50 or so years since Woodward's book was published, radar signal processing has used the ambiguity function as an intricate and flexible tool in the design of waveforms to solve diverse problems in radar. In the process, substantial connections were established in mathematics, physics, and other areas of signal processing. As such, we are introducing two new methods, discussed in sections "CAZAC Sequences" and "Aperiodic Simulations". [J954]

"Sparse Two-Dimensional Phase Unwrapping Using Regular-Grid Methods"

Phase unwrapping is usually defined as the reconstruction of a function sampled on a spatial grid given its value modulo 2pi. Phase unwrapping is a key step in image reconstruction in many imaging techniques including interferometric synthetic aperture radar (InSAR). In recent years, many new methods have been developed to exploit the presence of coherent or persistent scattering points for extracting deformation signatures in regions where the conventional InSAR fails. These techniques often yield measurements that are only poorly sampled spatially, yet these sparse data must still be unwrapped if we are to be able to extract useful geophysical information. The conventional well-sampled 2-D phase unwrapping problem based on phase residues is fairly well understood, and many novel techniques involving geometry and network flow concepts have been implemented successfully to date. For sparse data, residues may be computed over the Delaunay triangulation of the data points, but published algorithms meet with limited success when the sparse data are unwrapped. The advantages of modern unwrapping methods applicable to well-sampled data are often lost when sparse data are analyzed. In this letter, we show that a nearest neighbor interpolation scheme allows powerful and existing 2-D solvers to be applied to sparse data. We present results using both simulated and real data sets to illustrate our method. [J955]

"A Particle Filter Approach for InSAR Phase Filtering and Unwrapping"

This paper presents a new phase-unwrapping (PU) algorithm for SAR interferometry that makes use of a particle filter (PF) to perform simultaneously noise filtering and PU. The formulation of this technique provides independence from noise statistics and is not constrained by the nonlinearity of the problem. In addition, an enhanced variant of this method combining a PF with artificial-intelligence search strategies and an omnidirectional local phase estimator, based on the mode of the power spectral density, is also presented. Results obtained with synthetic and real data show a significant improvement with respect to other conventional unwrapping algorithms in some situations. [J956]

"On Detection Performance of MIMO Radar: A Relative Entropy-Based Study"

Based on Stein's lemma, we use relative entropy as a measure of error exponent to study detection performance of Neyman Pearson (NP) detectors for both multiple-input multiple-output (MIMO) radar and phased array radar. In high signal-to-noise ratio (SNR) region, we introduce the concept of diversity order to get insights of results. In low SNR region, we give instructive approximations for analytical results of relative entropy. Finally, we use relative entropy measure to study the problem of choosing the number of transmitters and receivers for MIMO radar. [J957]

"Efficient direct position determination of orthogonal frequency division multiplexing signals"

The authors present an efficient method for positioning of orthogonal frequency division multiplexing (OFDM) signals. The method, called direct position determination (DPD), enables one to determine the emitter position in a single search operation. In formerly published articles on DPD, the signal was assumed to be a narrowband Gaussian source, which was subjected to a rather simple flat-fading channel model. Here, the authors extend the DPD algorithm to handle the OFDM signals that propagate through a frequency-selective channel, and derive the least squares estimator (LSE) for the problem. In addition, the authors present a method for a fine 2D position estimation, which enables one to reduce the DPD computational complexity without compromising on its estimation accuracy. [J958]

"Two-dimensional pulse-to-pulse canceller of ground clutter in airborne radar"

It is well known that in the airborne radar, the location of the ground clutter spectrum in the angle-Doppler space is dependent mainly on the platform velocity and radar parameters. The authors propose a two-dimensional pulse-to-pulse canceller (TDPC) that can make full use of such prior information. The more detailed formulations of the ground clutter model and the signal model are given in a matrix-vector form. The least-squares-typical cost function associated with the filter coefficient matrix of the TDPC is established on the basis of the ground clutter model and the signal model. Like the classical displaced phase centre antenna (DPCA) processing, the proposed TDPC is also a spatial-temporal suppressor of ground clutter and can decrease the ground clutter signals, even though the DPCA condition is not satisfied. The proposed TDPC can also be used as an efficient pre-filtering tool before the conventional moving target indication (MTI) processing and the classical adaptive processing. Moreover, if only the TDPC plus the conventional MTI is used, it takes less computational time than the adaptive canceller. Experimental results show that the proposed TDPC has the satisfactory ground clutter suppression capability by using both simulated data and measured data. [J959]

"Orthogonal frequency-division multiplexing radar signal design with optimised ambiguity function and low peak-to-average power ratio"

Considering the important role of the ambiguity function (AF) of a signal regarding the performance of a matched filter bank for the detection of targets and the estimation of their ranges and velocities, the thumbtack shape is assumed to be the desirable shape of the AF and the method of least squares for the synthesis of the AF is introduced. Then, an iterative method for the allocation of a proper phase to the desired AF is proposed to obtain better results. This method is then applied to select the proper codes for the synthesis of pulsed orthogonal frequency-division multiplexing signals. It is also shown how this method can reduce sidelobes, almost uniformly, throughout the entire ambiguity plane. Finally, an efficient algorithm is presented, which modifies the produced codes in order to reach a lower peak-to-average power ratio suitable for transmission. [J960]

"Ionospheric clutter mitigation using one-dimensional or two-dimensional wavelet processing"

Ionospheric clutter mitigation is an important issue for high-frequency surface wave radar (HFSWR) signal processing. Clutter results from a sky wave propagation mode, which is backscattered by ionospheric ionisation irregularities. The random behaviour and the high strength of clutter signals can strongly limit the HFSWR detection capabilities. Here, an ionospheric clutter mitigation processing using wavelets is described. This new approach is founded on the ability of wavelets to separate signals having different variation scales or different directions of variations. The results obtained on real clutter signals with simulated targets are reported. Using the proposed method, one can expect, at mid-latitude, an improvement of the target-to-clutter ratio of 20-30-dB. [J961]

"A Graph-Theoretic Approach to Constrained Floor Plan Estimation From Radar Measurements"

This paper proposes an approach to deducing the floor plan of a building using only a set of noisy room dimension measurements that have been obtained indirectly through radar probes. It is not assumed that the set of measurements is complete. The key feature of this approach is a method of relating, via a graph-theoretical construction, a given floor plan topology to a model that depends linearly on a minimal set of parameters. Given a list of floor-plan topologies and a system of realizability constraints, it is possible to formulate this problem as a constrained least-squares optimization problem. An algorithm for generating all floor plan topologies with a specified number of rooms is presented, as well as an algorithm for deciding if two floor plan representations are isomorphic. The techniques in this paper are intended to serve as an exploration into the theoretical performance bounds on the floor plan estimation problem. [J962]

"Waveform-agile sensing for tracking"

Waveform-agile sensing is fast becoming an important technique for improving sensor performance in applications such as radar, sonar, biomedicine, and communications. The paper provided an overview of research work on waveform-agile target tracking. From both control theoretic and information theoretic perspectives, waveforms can be selected to optimize a tracking performance criterion such as minimizing the tracking MSE or maximizing target information retrieval. The waveforms can be designed directly based on their estimation resolution properties, selected from a class of waveforms with varying parameter values over a feasible sampling grid in the time-frequency plane, or obtained from different waveform libraries. [J963]

"Target Estimation, Detection, and Tracking"

In this article, we explore the adaptive design of radar polarization waveforms for optimal performance, when the statistical properties of the target and clutter are unknown. We focus on a closed-loop system that sequentially

estimates the target and clutter scattering parameters, and then uses these estimates to select the polarization of the subsequent waveforms. We demonstrate that the radar system performance is significantly improved when the polarization of the transmitted signal is optimally and adaptively selected to match the polarimetric aspects of the target and environment. In particular, we provide an overview of our recent results showing that the adaptive design of the radar signal polarization enables achieving optimal performance in several operating modes, including detection, estimation, and tracking. [J964]

"Waveform Diversity in Radar Signal Processing"

This article shows that suitably transmitted and processed, radar waveforms based on Golay sequences provide new primitives for adaptive transmission that enable better detection and finer resolution, while managing computational complexity at the receiver. The ability to exploit space-time adaptive processing is limited by the computational power available at the receiver, and increased flexibility on transmission only exacerbates this problem unless the waveforms are properly designed to simplify processing at the receiver. [J965]

"Lessons for Radar"

Echolocating mammals such as bats, whales and dolphins have been using waveform diversity for over 50 million years. Synthetic systems such as sonar and radar have existed for fewer than 100 years. Given the extraordinary capability of echolocating mammals it seems self-evident that designers of radar (and sonar) systems may be able to learn lessons that may potentially revolutionize current radar-based capability leading to truly autonomous navigation, collision avoidance, and automatic target classification. Echolocating mammals have been little studied in relation to the operation of radar and sonar systems. In this article, we introduce a range of strategies employed by bats and consider how these might be exploitable in the radar systems of tomorrow. Specifically, we concentrate on the functions necessary for autonomous navigation. Echolocating mammals are known to vary their waveforms via modification to the pulse-repetition frequency (PRF), also known to biologists as pulse-repetition rate (PRR), power, and frequency content of their transmitted waveforms. This has enabled them to evolve highly sophisticated orientation techniques and the ability to successfully forage for food. Moreover, recent developments in technology mean that it is now possible to replicate these parametric variations in synthetic sensing systems such as radar and sonar. [J966]

"Energy-Efficient Routing for Signal Detection in Wireless Sensor Networks"

For many envisioned applications of wireless sensor networks (WSNs), the information processing involves dealing with distributed data in the context of accurate signal detection and energy-efficient routing, which have been active research topics for many years, respectively. In this paper, we relate these two aspects via joint optimization. Considering the scenario of using distributed radar-like sensors to detect the presence of an object through active sensing, we formulate the problem of energy- efficient routing for signal detection under the Neyman-Pearson criterion, apparently for the first time. The joint optimization of detection and routing is carried out in a fusion center which precomputes the routes as a function of the geographic location to be monitored. Accordingly, we propose three different routing metrics that aim at an appropriate tradeoff between the detection performance and the energy expenditure. In particular, each metric relates the detection performance explicitly in terms of probabilities of detection and false alarm, with the energy consumed in sensing and routing. The routing problems are formulated as combinatorial optimization programs, and we provide solutions drawing on operations research. We present extensive simulation results that demonstrate the energy and detection performance tradeoffs for each proposed routing metric. [J967]

"Cassini RADAR Sequence Planning and Instrument Performance"

The Cassini RADAR is a multimode instrument used to map the surface of Titan, the atmosphere of Saturn, the Saturn ring system, and to explore the properties of the icy satellites. Four different active mode bandwidths and a passive radiometer mode provide a wide range of flexibility in taking measurements. The scatterometer mode is used for real aperture imaging of Titan, high-altitude (around 20 000 km) synthetic aperture imaging of Titan and Iapetus, and long range (up to 700 000 km) detection of disk integrated albedos for satellites in the Saturn system. Two SAR modes are used for high- and medium-resolution (300-1000 m) imaging of Titan's surface during close flybys. A high-bandwidth altimeter mode is used for topographic profiling in selected areas with a range resolution of about 35 m. The passive radiometer mode is used to map emission from Titan, from Saturn's atmosphere, from the rings, and from the icy satellites. Repeated scans with differing polarizations using both active and passive data provide data that can usefully constrain models of surface composition and structure. The radar and radiometer receivers show very good stability, and calibration observations have provided an absolute calibration good to about 1.3 dB. Relative uncertainties within a pass and between passes can be even smaller. Data are currently being processed and delivered to the planetary data system at quarterly intervals one

year after being acquired. [J968]

"Omega-k Algorithm for Airborne Forward-Looking Bistatic Spotlight SAR Imaging"

For flexibility and cost reduction, the forward-looking bistatic spotlight synthetic aperture radar (FL-BSSAR) which uses the side-looking transmitter and the forward-looking receiver has been studied recently. For the FL-BSSAR imaging, we introduce a modified omega-k algorithm. Specifically, using rotation and shifting of the receiver path and resampling of the transmitter path, we convert the FL-BSSAR into the side-looking BSSAR. Then, we modify the matched filter and Stolt interpolation using the principle of the stationary phase to obtain the SAR image. Simulation results show that the modified omega-k algorithm enhances the image quality. [J969]

"A New Way to Model Nonstationary Sea Clutter"

Sea clutter refers to the radar backscatter from a patch of ocean surface. To properly characterize radar clutter returns, a lot of effort has been made to fit various distributions to the observed amplitude data of sea clutter. However, the fitting of real sea clutter data using those distributions is not satisfactory. This may be due to the fact that sea clutter data is highly nonstationary. This nonstationarity motivates us to perform distributional analysis on the data obtained by differentiating the amplitude data of sea clutter. By systematically analyzing differentiated data of 280 sea clutter time series measured under various sea and weather conditions, we show that the Tsallis distribution fits sea clutter data much better than commonly used distributions for sea clutter such as the K distribution. We also find that the parameters from the Tsallis distribution are more effective than the ones from the K distribution for detecting low observable targets within sea clutter. [J970]

"A Non-Contact-Type RF MEMS Switch for 24-GHz Radar Applications"

This paper presents the design, fabrication, and measurement results for a novel non-contact-type radio-frequency (RF) microelectromechanical systems switch for 24-GHz radar applications. The proposed switches are free from unavoidable microwelding and stiction problems in other contact types, which in turn guarantee high reliability and long lifetime. The developed switch is a capacitive shunt type using a variation of the capacitance between the signal line and ground lines. The capacitance is precisely regulated by comb-drive actuators. This concept is simple, but the design requires a large and precise mechanical motion. In addition, for a low-loss switch structure, an air bridge with a large air gap is required. Therefore, the selective silicon-on-insulator process, based on the sacrificial bulk micromachining process, is designed for this switch fabrication. First, large insulating supports are fabricated 60 ??m below the wafer surface, and then, the RF switch is fabricated on these insulating supports. The measured actuation voltage is 25 V, and the actuation stroke is 25 ? ?m. The switching times are 8 ms in the off to the on state and 200 ??s in the on to the off state. In the RF characteristic measurements, the insertion loss without the long coplanar waveguide line loss is 0.29 dB and the isolation is 30.1 dB at 24 GHz. The bandwidth is relatively narrow, and the isolation is 25 dB or better in the range of 23.5-29 GHz. The reliability test for the switch was performed 109times with 18-mW RF power. We observed no mechanical failure or RF performance degradation. A power handling capacity of 0.9 W with a hot-switch condition was achieved. [J971]

"Optimization of Soil Hydraulic Model Parameters Using Synthetic Aperture Radar Data: An Integrated Multidisciplinary Approach"

It is widely recognized that synthetic aperture radar (SAR) data are a very valuable source of information for the modeling of the interactions between the land surface and the atmosphere. During the last couple of decades, most of the research on the use of SAR data in hydrologic applications has been focused on the retrieval of land and biogeophysical parameters (e.g., soil moisture contents). One relatively unexplored issue consists of the optimization of soil hydraulic model parameters, such as, for example, hydraulic conductivity values, through remote sensing. This is due to the fact that no direct relationships between the remote-sensing observations, more specifically radar backscatter values, and the parameter values can be derived. However, land surface models can provide these relationships. The objective of this paper is to retrieve a number of soil physical model parameters through a combination of remote sensing and land surface modeling. Spatially distributed and multitemporal SAR-based soil moisture maps are the basis of the study. The surface soil moisture values are used in a parameter estimation procedure based on the extended Kalman filter equations. In fact, the land surface model is, thus, used to determine the relationship between the soil physical parameters and the remote-sensing data. An analysis is then performed, relating the retrieved soil parameters to the soil texture data available over the study area. The results of the study show that there is a potential to retrieve soil physical model parameters through a combination of land surface modeling and remote sensing. [J972]

"MTT is GOLD! [JFrom the Editors' Desk]"

Unlike previous special issues of IEEE Microwave Magazine, this one is not dedicated to a specific topic within the microwave arena. Rather, it is built under the umbrella of an idea; the idea behind Graduates of the Last Decade (GOLD). GOLD was instituted by the IEEE in 1996 with the charter of helping young professionals transition from being a student to entering the professional world. [J973]

"An Improved Technique to Predict the Time-of-Arrival of a Tumor Response in Radar-Based Breast Imaging"

Radar-based microwave imaging has been proposed as a complementary modality for early-stage breast cancer screening. This paper presents an algorithm that may be used to accurately predict the time-of-arrival (TOA) of a tumor response contained in sample data acquired from a small number of antennas in a realistic scenario. The TOA information may be used by many of the existing radar-based methods to detect and localize a tumor response. The robustness of the algorithm is demonstrated with data generated from realistic numerical breast models. [J974]

"A lighter side to heaviside [JEnigmas, etc.]"

{no data available} [J975]

"Radar remote monitoring of vital signs"

Medical technology has improved remarkably over the past few generations, becoming more sophisticated and less invasive as the years progress. Now, with microwave Doppler radar phase modulation, noncontact respiration and heartbeat monitoring offers an attractive alternative to commonly prescribed chest-strap monitors. Doppler radar uses double-sideband transmission for vital sign detection from four sides of a human body. An unmodulated radio-frequency signal is transmitted toward the human body, where it is phase-modulated by the periodic physiological movement and reflected back to the receiver. The radar receiver captures the reflected signal and demodulates it to extract the vital sign signal components. [J976]

"In-band interference reduction in FMCW channel data using Prony modelling"

He is shown that Prony modelling can be used to reduce the effect of in-band interference in frequency modulated continuous-wave (FMCW) channel data. Results of the modelling are examined by comparing average power delay profiles and Doppler spectra with those obtained from FFT processing. [J977]

"New applications of transponder in focusing distributed synthetic aperture radar data"

High-precision phase synchronisation or compensation techniques must be provided for distributed synthetic aperture radar (DiSAR), which operates with separate transmitters and receivers. The use of a novel transponder that was proposed for calibrating high-resolution imaging radars to compensate oscillator frequency instability is investigated here. This transponder modulates the radar pulses in a manner that the retransmitted signal shows two additional Doppler frequencies, which enables their separation from the scene echoes. In this way, DiSAR frequency synchronisation errors can be compensated. Thereafter, the DiSAR raw data is focused by using a derived image formation algorithm. The originality of this text lies in the phase compensation technique via transponder for DiSAR systems, as well as an image formation algorithm with integrated synchronisation compensation. [J978]

"Discrete frequency-coded radar signal design"

A modified simulated annealing algorithm (MSAA) is proposed as combinatorial multivariable optimisation technique to design discrete frequency-coding (DFC) sequence sets with good auto- and cross-correlation properties. The proposed algorithm is a combination of simulated annealing and Hamming scan algorithm. MSAA has global minimum estimation capability of simulated annealing and fast convergence rate of Hamming scan algorithm. Some of the synthesised results are presented, the properties of the sequence sets are shown to be better than the other sequence sets known in the literature. Synthesised DFC sequence sets have properties far better than polyphase sequence sets. The synthesised DFC sequence sets are promising for practical application to netted radar/multiple radar systems. [J979]

"Radio eye in the sky"

its baggage door, the Cessna 172 looks unremarkable, at least for one of its ageГ‚Вїthis single-engine plane was built during the Apollo program. But behind that lump is mounted a radar set far more sophisticated than anything NASAГ‚Вїs astronauts ever took to the moon. [J980]

"New Algorithms for Designing Unimodular Sequences With Good Correlation Properties"

Unimodular (i.e., constant modulus) sequences with good autocorrelation properties are useful in several areas, including communications and radar. The integrated sidelobe level (ISL) of the correlation function is often used to express the goodness of the correlation properties of a given sequence. In this paper, we present several cyclic algorithms for the local minimization of ISL-related metrics. These cyclic algorithms can be initialized with a good existing sequence such as a Golomb sequence, a Frank sequence, or even a (pseudo)random sequence. To illustrate the performance of the proposed algorithms, we present a number of examples, including the design of sequences that have virtually zero autocorrelation sidelobes in a specified lag interval and of long sequences that could hardly be handled by means of other algorithms previously suggested in the literature. [J981]

"Dual polarised wideband metamaterial radar absorbing screen based on resistive Hilbert curve array"

A novel thin metamaterial wideband radar absorber formed by two layers of resistive Hilbert curve arrays is reported. HFSS simulations reveal a reduction in the monostatic radar cross-section of more than 10 dB from 8 to 18.8 GHz (81 fractional bandwidth) for Exand 9.1 to 20.7 GHz (78 fractional bandwidth) for Eypolarisations, respectively. This bandwidth is significantly wider than those reported so far for space filling curve array based absorbers. The structure has a thickness of only 0.17lambda at fo(14.2 GHz). The lateral dimensions are only 0.2 0.2 per unit cell at fo, which is several times smaller than that of recently reported circuit analogue absorbers operating in the similar frequency band, thus suppressing diffraction effects. [J982]

"Rain Rate Estimation Using Measurements From Commercial Telecommunications Links"

In this paper, we propose a novel method for estimating the rain rate at any given point within a two-dimensional plain using measurements of the received signal level extracted from power control records of an existing deployed fixed wireless communication network. The path-average rainfall intensity along each microwave radio link is estimated from the rainfall-induced attenuation using an empirical relationship. The proposed algorithm consists of appropriate preprocessing of the links data, followed by a modified weighted least squares algorithm to infer on the rain level at any given point in space. The algorithm can be used to interpolate measurements onto a regular grid to construct a two-dimensional rainfall intensity field. The novelty of the proposed estimation method comes from its ability to be applied on an arbitrary geometry network comprising different microwave links lengths and frequencies and allowing easy integration of rain gauge observations into the model to improve estimation accuracy. The technique has been applied to an existing fixed wireless communication network comprising 22 microwave links covering an area of about 15times15 km2and operating at carrier frequencies of about 20 GHz. The resulting rainfall field estimates have been compared to rain gauge stations in the vicinity and to weather radar data, showing good agreement. [J983]

"Improved, Approximate, Time-Domain ML Estimators of Chirp Signal Parameters and Their Performance Analysis"

We derive an improved, approximate, maximum likelihood (ML) estimator for the parameters of a single-component chirp signal in the time domain, which has much lower computational complexity than that of the traditional estimators in the frequency domain. We term it the zero-order amplitude weighted phase-based estimator (AWPE). It is a weighted linear combination of the phases of the received signal samples, where the weights are determined by the amplitudes of the received signals. It achieves better performance than the only existing time-domain estimator in the literature that only exploits the phase information. A phase unwrapping (PU) algorithm is needed to recover the phase information correctly from the received signal samples. Several PU algorithms are compared and analyzed. A new, robust PU algorithm based on the first-order phase differences of the consecutive received signal samples is proposed. This new unwrapping algorithm has smaller PU failure probability than that based directly on the phases of the received signal samples. The need for PU can even be removed by using the second-order phase differences of the consecutive received signal samples. Two additional structures for the ML-based AWPE using the phase differences are derived starting from using the zero-order AWPE obtained. The first is based on the first-order phase differences and the second on the second-order phase differences. When the PU algorithm works perfectly, i.e., no phase unwrapping failure occurs, the estimators based on phase differences do not perform as well as the original one based on absolute phase information due to the increased noise variance. This is also applicable when the chirp parameters take on very small values. However, when no knowledge of the ranges of the chirp parameters is available, and the possible PU failures are taken into account, the estimators based on the phase differences could perform better. Performance analysis of the estimators is given based on--an improved phase noise model. It is easy to verify that the estimates obtained are unbiased. The cramer-rao lower bound (CRLB) on the mean-square error (MSE)

is derived. The MSE performance of the estimators approaches the CRLB at high signal-to-noise ratios. The variance performance of the estimators based on phase differences is analyzed, whose validity is demonstrated by simulation results. [J984]

"Space-Surface Bistatic SAR Image Formation Algorithms"

This paper presents algorithms designed for a subclass of bistatic synthetic aperture radar (BSAR) called space-surface BSAR (SS-BSAR). Two SS-BSAR configurations are considered. The first one assumes a stationary, spaceborne transmitter and a moving airborne receiver. The second case is the generalized SS-BSAR configuration, where the transmitter is nonstationary. The transmitter and receiver have essentially different flight paths and velocities. For each configuration under investigation, the characteristics of the corresponding SS-BSAR received signal are examined first. Then, each proposed algorithm is derived analytically, and verified via simulation. [J985]

"Waveform-Diversity-Based Millimeter-Wave UAV SAR Remote Sensing"

To integrate a synthetic aperture radar (SAR) into an operational unmanned airborne vehicle (UAV), it should be as small as possible to meet stringent limitations of size, weight, and power consumption. It appears that the novel combination of millimeter-wave frequency-modulated continuous-wave (FMCW) technology and SAR techniques can provide an optimal solution. However, some efficient techniques should be applied to resolve range/Doppler ambiguities in FMCW UAV SAR systems. As such, a technique of waveform-diversity-based millimeter-wave UAV SAR imaging is presented in this paper. Along with the described system concept and signal model, the performance of the diversified waveforms evaluated by their cross correlations is detailed. As the conventional stop-and-go approximation is not valid for FMCW SAR, a modified wavenumber-domain algorithm with a consideration of continuous antenna motion during transmission and reception is derived. This imaging algorithm is validated with computer simulations. Furthermore, one parallel direct-digital-synthesizer-driven phase-locked-loop synthesizer with adaptive nonlinearity compensation, which has been validated by the experimental results, is proposed to obtain a millimeter-wave FMCW signal with fine frequency linearity. [J986]

"Monitoring of the Rice Cropping System in the Mekong Delta Using ENVISAT/ASAR Dual Polarization Data"

The rice cropping system in Asia is undergoing major changes to cope with increasing demography and changing climate, making rice monitoring a critical issue. Past studies have demonstrated the use of C-band synthetic aperture radar (SAR) data to map rice areas. The methods were based on the temporal change of intensity backscattering coefficient of vertically or horizontally co-polarized data (VV or HH). In this paper, we assess the use of the HH/VV polarization ratio derived from Advanced SAR (ASAR) data from ENVISAT data for the production of rice paddy maps. The approach is based on past knowledge on the polarization behavior of rice canopy, i.e., VV backscattering is much lower than HH during a large part of the rice season, due to the attenuation of the wave by the vertical structure of the plants. The methodology is developed for the Mekong Delta, Vietnam, where a complex cropping pattern is found (one to three crops of rice per year). The approach includes a statistical analysis of the HH/VV distributions of rice and non-rice classes at different dates. The analysis results confirm that HH/VV can be used as classifier and point out the need for relevant speckle filtering prior to classification. A classification method is developed and applied to single- and multidate data sets. The methods are tested at one district of the province of An Giang and extended to the whole province. Comparisons of the mapping results to geographic-information-system land-use data and official agricultural statistics show very good agreement. The method will be further applied to the entire Mekong Delta. [J987]

"Application of Target Decomposition Theorems Over Snow-Covered Forested Areas"

This paper compares two well-known polarimetric decomposition theorems, Cloude-Pottier and Freeman-Durden, applied to L- and C-band Airborne Polarimetric Synthetic Aperture Radar (AIRSAR-POLSAR) data acquired during the Cold-Land Processes Field Experiments. Three field campaigns were carried out in February 2002, March 2002, and March 2003 over a snow-covered open terrain, a sparse coniferous forest, and a dense coniferous forest. The analysis evaluates the ability of the two target decomposition methods for the identification and understanding of the main scattering mechanisms. [J988]

"Pencil Back-Projection Method for SAR Imaging"

We present a high-resolution method for spotlight mode SAR imaging that utilizes parametric modeling of projected target reflectivity density function and tomographic reconstruction. The method requires no polar-to-cartesian interpolation in spectral domain. Utilization of forward-backward total least squares bandpass matrix

pencil method allows super resolution to be achieved in range for a single imaging angle. Hence, the quality of the image reconstructed by convolution back-projection is also improved. It is shown that the method is very resistant to noise and can generate images down to very low SNR values. Direct formulation in terms of physical quantities such as electric field and current density is another contribution of this paper. [J989]

"DEM Reconstruction in Layover Areas From SAR and Auxiliary Input Data"

In this letter, a methodology to overcome the layover problem and obtain the 3-D reconstruction of urban areas will be discussed. Interferometric synthetic aperture radar (SAR) (InSAR) systems allow the estimation of height profiles of the Earth surface, but in the case of urban scenarios, estimation becomes a hard task due to the presence of SAR geometrical distortions, with layover above all. First, the layover signal in InSAR images is investigated; then, a procedure to specifically manage layover areas is presented. The proposed method consists of introducing an auxiliary data exploitation, optical data or SAR shadowing, in the maximum a posteriori statistical estimation technique to improve the digital elevation model reconstruction, particularly on phase discontinuities. We test the method on simulated data, showing its effectiveness. [J990]

"An Assessment of a Ka-Band Radar Interferometer Mission Accuracy Over Eurasian Rivers"

The Water Elevation Recovery satellite mission is dedicated to the determination of land surface water extent, elevation, and slope using a Ka-band radar interferometer (KaRIn) as its primary instrument. Determining these parameters to the accuracy desired for hydrologic applications is challenging. The scientific objectives of the mission have been set up to 10 cm for the height budget and 10 murad (1 cm/1 km) for the slope budget. In this paper, we implement a Virtual Mission simulation and use it to examine the measurement performances for three case studies in Europe: a relatively small river such as the Meuse in Northern Western Europe, the Lena river in Russia, one of the major Siberian rivers, and Lake Leman in Western Europe. We simulate KaRIn data with the associated instrument and geophysical error sources and implement ground processing techniques to go from the original raw data to science data. We examine the impact of external errors in detail and implement calibration techniques that rely on the use of ancillary topographic data, such as the Shuttle Radar Topography Mission digital elevation model (DEM). We find that the impact of external errors can be reduced to a few centimeters. The random error budget can also be reduced below 10 cm by means of appropriate processing. The scientific requirements of the mission are shown to be met for all cases. [J991]

"High-Resolution Radar via Compressed Sensing"

A stylized compressed sensing radar is proposed in which the time-frequency plane is discretized into an N times N grid. Assuming the number of targets K is small (i.e., K Lt N2), then we can transmit a sufficiently ldquoincoherentrdquo pulse and employ the techniques of compressed sensing to reconstruct the target scene. A theoretical upper bound on the sparsity K is presented. Numerical simulations verify that even better performance can be achieved in practice. This novel-compressed sensing approach offers great potential for better resolution over classical radar. [J992]

"Snowpack Characterization in Mountainous Regions Using C-Band SAR Data and a Meteorological Model"

This paper presents a method to characterize snow cover in mountainous regions using dual-polarization C-band synthetic aperture radar (SAR) data. It is demonstrated that an accurate modeling of the liquid water distribution inside the snowpack, using a multilayer meteorological snow model, is required to characterize snow with precision. A multilayer-snow electromagnetic (EM) backscattering model is developed based on the vector radiative transfer, the strong fluctuation theory, and physical parameters supplied by the meteorological model. However, the limited resolution of the meteorological snow model is insufficient for predicting a refined EM backscattering at a massif scale. An adequate spatial reorganization of these snow profiles, based on a comparison between simulated and measured dual-polarization SAR data, leads to a better estimation of some snowpack parameters. In particular, the monitoring of snow liquid water content is presented improving the capacity of wet snow mapping as compared to a classical SAR-based method. This methodology shows good capacities both for qualitative and quantitative snow assessments, opening the way for a new operational method. [J993]

"Profiling the Rough Surface by Migration"

It is often advantageous to estimate the ground surface topography from radar returns. However, the popular method, searching for the brightest pixel in the ground-penetrating radar profile, cannot achieve accurate surface topography in the sharp variable surface case because of the effects of diffraction waves. In this letter, we propose a method to solve the problem and improve the accuracy of surface topography. A migration technique

is introduced to refocus the diffraction waves before searching for the brightest pixel. Experimental data have been used to display the effects of diffraction waves and test the method. The result shows that the method can dramatically estimate accurate surface topography even in the sharp variable surface area. [J994]

"Glacier Velocity Monitoring by Maximum Likelihood Texture Tracking"

The performance of a tracking algorithm considering remotely sensed data strongly depends on a correct statistical description of the data, i.e., its noise model. The objective of this paper is to introduce a new intensity tracking algorithm for synthetic aperture radar (SAR) data, considering its multiplicative speckle/noise model. The proposed tracking algorithm is discussed regarding the measurement of glacier velocities. Glacier monitoring exhibits complex spatial and temporal dynamics including snowfall, melting, and ice flows at a variety of spatial and temporal scales. Due to these complex characteristics, most traditional methods based on SAR suffer from speckle decorrelation that results in a low signal-to-noise ratio. The proposed tracking technique improves the accuracy of the classical intensity tracking technique by making use of the temporal speckle structure. Even though a new intensity-based matching algorithm is proposed, particularly for incoherent data sets, the analysis of the proposed technique was also performed for correlated data sets. As it is demonstrated, the velocity monitoring can be continuously performed by using the maximum likelihood (ML) texture tracking without any assumption concerning the correlation of the data set. The ML texture tracking approach was tested on ENVISAT-ASAR data acquired during summer 2004 over the Inyltshik glacier in Kyrgyzstan, representing one of the largest alpine glacier systems of the world. It will be demonstrated that the proposed technique is capable of robustly and precisely detecting the surface velocity field and velocity changes in time. [J995]

"TerraSAR-X Precise Trajectory Estimation and Quality Assessment"

Since the launch of TerraSAR-X on June 15, 2007, the required precise orbit products have been provided by the German Space Operations Center to support operational spaceborne synthetic aperture radar (SAR) and interferometric SAR image processing. The TerraSAR-X precise trajectory is reconstructed solely based on the Global Positioning System (GPS) measurements from a geodetic-grade dual-frequency Integrated Geodetic and Occultation Receiver (IGOR) onboard the spacecraft. The GPS-based precise orbit determination (POD) strategy used in the estimation of the precise TerraSAR-X orbit and its performance will be fully described in this paper. Five-month statistics from the internal and external orbit assessment indicate a root-mean-squared 3-D orbit accuracy of better than 10 and 20 cm for the precise science orbit and precise rapid orbit (PRO) products, respectively. The POD performance of the backup single-frequency MosaicGNSS receiver to support operational PRO product generation in case of IGOR tracking failure or interruptions is described as well. [J996]

"Short-Range Clutter Suppression for Airborne Radar by Utilizing Prefiltering in Elevation"

Space-time adaptive processing (STAP) techniques have achieved good performance when applied to side-looking airborne radar (SLAR) where the ground clutter is relatively stationary, but due to severe range dependence, the performance is not so good in non-SLAR particularly when the pulse repetition frequency is high enough to induce range ambiguity. Because the short-range clutter Doppler for non-SLAR varies rapidly with range while the long-range clutter Doppler varies gently, at the presence of range ambiguity, the clutter in different ambiguous ranges does not coincide. The clutter range dependence mitigation for the case of range ambiguity is the major problem that this letter intends to solve. A subarray synthesis algorithm with prefiltering in elevation is presented. By this technique, the ambiguous short-range clutter is eliminated before STAP; therefore, the clutter range dependence is alleviated, and then, the STAP performance will be improved greatly. [J997]

"Wheat Crop Mapping by Using ASAR AP Data"

The purpose of this paper is to assess the use of C-band HH/VV backscatter ratio for mapping winter wheat. This paper analyzes two temporal series of images acquired in 2006 and 2007 by the Advanced Synthetic Aperture Radar (ASAR) system in alternating polarization (AP) mode, over an agricultural site located in southern Italy. Results on test data show that classification accuracies between 75% and 80% can be achieved by using a single ASAR image, acquired during the peak of the wheat-growing season. To achieve accuracies close to 90%, a spatial averaging at field scale is necessary. [J998]

"Estimation of the Minimum Number of Tracks for SAR Tomography"

Synthetic aperture radar tomography (SARTom) is the natural extension of SAR interferometry to solve for multiple phase centers within a resolution cell and obtain the 3-D representation of a scene. This paper deals with the determination of the minimum number of tracks required to perform SARTom. Through the prolate spheroidal wave functions, the number of equivalent targets of a volumetric source is derived, and from it, the

minimum number of observations required to apply subspace superresolution methods is computed. The minimum tomographic aperture length is also investigated. The results are validated on real data acquired in L-band by the experimental SAR system of the German Aerospace Center. [J999]

"A Short-Range Ship Navigation System Based on Ladar Imaging and Target Tracking for Improved Safety and Efficiency"

A new maritime navigation system based on a laser range-finder scanner for obstacle avoidance and precise maneuvering operations is described in this paper. The main novelty of this work is the adaptation and implementation of known technology for laser range finding and algorithms for target tracking into a system that operates in real time and has been tested in different natural sea and inland navigation scenarios. The principal components of this system, namely, 1) the laser range finder, 2) the scanning unit, and 3) the data processing and displaying unit, are described in detail. Ladar images are dense horizontally and sparse vertically as a compromise between capturing relevant features and quick frame formation. Images are processed for range outlier removal, and significant observable patterns are extracted. This multiple-target tracking problem is tackled using robust Kalman filtering techniques for continuous tracking of each detected observation. We minimize unreliable track initializations and preserve tracks from deletion during temporal misobservations. The evaluation in open-sea and inland waterways gave good results, making the system valid for precise maneuvering, fluent navigation, and accident mitigation. Objects of interest, from boats to ships, are detected and robustly tracked; pier and lock chamber sketches are reliable; bridge height estimation is precise; and narrow waterways (river banks and bridge columns) are correctly detected. The prototype developed can be considered to be a very valuable complementary device to traditional radar-based techniques that are not totally valid for accurate short-range exploration, improving efficiency and safety in ship operations. [J1000]

"Signal-to-Noise Ratio in Doppler Radar System for Heart and Respiratory Rate Measurements"

A CMOS Doppler radar sensor has been developed and used to measure motion due to heart and respiration. The quadrature direct-conversion radar transceiver has been fully integrated in 0.25-mum CMOS, the baseband analog signal conditioning has been developed on a printed circuit board, and digital signal processing has been performed in Matlab. The theoretical signal-to-noise ratio (SNR) is derived based on the radar equation, the direct-conversion receiver's properties, oscillator phase noise, range correlation, and receiver noise. Heart and respiration signatures and rates have been measured at ranges from 0.5 to 2.0 m on 22 human subjects wearing normal T-shirts. The theoretical SNR expression was validated with this study. The heart rates found with the radar sensor were compared with a three-lead electrocardiogram, and they were within 5 beats/min with 95% confidence for 16 of 22 subjects at a 0.5-m range and 11 of 22 subjects at a 1.0-m range. The respiration rates found with the radar sensor were compared with those found using a piezoelectric respiratory effort belt, and the respiration rates were within five respirations per minute for 18 of 22 subjects at a 0.5-m range, 17 of 22 subjects at a 1.0-m range, and 19 of 22 subjects at a 1.5-m range. [J1001]

"Fast implementation of optimal target radial velocity estimation for multi-channel SAR-GMTI"

Optimal target radial velocity estimation for SAR-GMTI using polynomial rooting is developed. The developed method first obtains all extreme values of the likelihood function by polynomial rooting, and then searches the maximum among these extreme values to obtain the global optimal solution. It has much lower computational complexity compared to the velocity search method when the search step is small. Simulation results are given to demonstrate the effectiveness of the method. [J1002]

"RF MEMS on the radar"

This article gives an overview of applications of radio frequency (RF) microelectromechanical system (MEMS) technology in radio detection and ranging (radar). RF MEMS components for radar include attenuators, limiters, (true-time-delay) phase shifters, transmit/receive (T/R) switches and tunable matching networks. Radar subsystems that benefit from RF MEMS technology include active electronically scanned arrays (T/R modules), passive electronically scanned arrays (lenses, reflect arrays, subarrays, and switched beamformers), and radomes. Using a bottom-up approach, the figures of merit for RF MEMS technology are related to the figures of merit for radar subsystems. The article also discusses ultrawideband RF MEMS reflect array and T/R module design as examples. First, electronically scanned array, radar and RF MEMS fundamentals are briefly introduced. [J1003]

"Automatic Target Recognition by Means of Polarimetric ISAR Images and Neural Networks"

Inverse synthetic aperture radar (ISAR) images are often used for classifying and recognizing targets. Moreover, the use of fully polarimetric ISAR (Pol-ISAR) images enhances classification capabilities. In this paper, the

authors propose a novel automatic target recognition (ATR) technique based on the use of fully Pol-ISAR images and neural networks (NNs). In order to reduce the amount of data processed by the classifier, the brightest scattering centers are first extracted by means of the Pol-CLEAN technique, and then, their scattering matrices are decomposed using Cameron's decomposition. A classifier based on the use of multilayer perceptron NN that makes use of the features extracted from the Pol-ISAR images is then implemented. A proof-of-concept test is performed on real data acquired during a controlled experiment in an anechoic chamber. [J1004]

"Hidden Word"

{no data available} [J1005]

"Scattered EM Field Responses of Canonical Scatterers Illuminated by an Impulse-Radiating Antenna (IRA)"

This paper investigates the possibility of using the impulse-radiating antenna (IRA) as both a transmitter and receiver of electromagnetic energy for the purpose of target identification. Of specific interest is estimating the induced open-circuit voltage at the IRA's source terminals, when it is illuminated by the scattered EM field from simple conducting bodies excited by an incident field from the same IRA acting as a transmitter. In this study, several different canonical scatters are considered, including thin wires, spheres, conducting boxes, and an infinite conducting plate. For a 7 kV pulse excitation of the IRA, received peak transient voltages at the antenna ranged from a few volts to about 400 volts, depending on the scatterer. [J1006]

"The Application of the Principle of Chirp Scaling in Processing Stepped Chirps in Spotlight SAR"

A new approach to process stepped chirps in spotlight synthetic aperture radar is presented in this letter, which is based on exploiting the principle of chirp scaling (PCS). In particular, PCS is integrated into the polar format algorithm (PFA), obtaining a more efficient solution compared with the existing polar interpolation technique. The main contribution of this letter is the implementation of azimuth scaling, in which the bandwidth synthesis is embedded. The algorithm is developed dedicatedly for dealing with stepped chirps. The signal processing flow is investigated in detail, in which no interpolations but only fast Fourier transform and complex multiplications are involved. Point-target simulation has validated the new approach and indicated that it is more efficient than the classic interpolation-based one. The achieved computational gain measured in execution time is around 25%-30%. [J1007]

"Reconfigurable planar filters"

Electronically reconfigurable or tunable microwave filters are attracting more attention for research and development because of their increasing importance in improving the capability of current and future wireless systems. For instance, emerging ultrawideband (UWB) technology requires the use of a wide radio spectrum. However, the frequency spectrum as a resource is valuable and limited, so the spectrum is always being used for several purposes, which means it is full of unwanted signals when an operation such as a UWB wireless system is concerned. In this case, existing undesired narrowband radio signals, which vary from place to place and from time to time, may interfere with the UWB system's range. A solution for this is to introduce an electronically switchable or tunable narrow rejection band (notch) within the passband of a UWB bandpass filter. Such an electronically reconfigurable filter is also desired for wideband radar or electronic warfare systems. This paper discusses the development of electronically reconfigurable filter types. [J1008]

"Science and Engineering on Petascale Computers"

The guest editor argues that we can't just construct the fastest possible machines; we must build comprehensive programs around those machines. The four articles in this issue provide the reader with a sense of the current state of petascale computing, its opportunities and challenges, and its implications. [J1009]

"Combinatorial discriminant analysis: supervised feature extraction that integrates global and local criteria"

Supervised feature extraction (SFE) algorithms can be divided into two categories: those optimised by global criteria and those optimised by local ones. Proposed is a new approach designed by integrating global and local criteria, namely, combinatorial discriminant analysis (CDA), to perform SFE. It is shown that CDA inherits both the robustness of global criteria and the flexibility of local ones. Experimental comparisons with typical global and local SFE algorithms on real-world datasets empirically justify the superiority of CDA. [J1010]

"Algebraic Synthesis of Forest Scenarios From Multibaseline PolInSAR Data"

In this paper, a new methodology is proposed for the analysis of forested areas basing on multipolarimetric multibaseline synthetic aperture radar (SAR) surveys. Such a methodology is based on three hypotheses: 1) statistical uncorrelation of the different scattering mechanisms (SMs), such as ground, volume, and ground-trunk scattering; 2) independence of volumetric and temporal coherence losses of each SM on the choice of the polarimetric channel; and 3) invariance (up to a scale factor) of the average polarimetric signature of each SM with respect to the choice of the track. Under these hypotheses, the data covariance matrix can be expressed as a Sum of Kronecker Products, after which it follows that K SMs are uniquely identified by K (K-1) real numbers. This result provides the basis to perform SM separation by employing not only model-based approaches, generally retained in literature but also model-free and hybrid approaches, while yielding the best Least Square solution given the hypothesis of K SMs. It will be shown that this approach to SM separation is consistent with the inversion procedures usually exploited in single-baseline polarimetric SAR interferometry. Experimental validation of this methodology is provided on the basis of the P-band data set relative to the forest site of Remningstorp, Sweden, acquired by German Aerospace Center's E-SAR airborne system in the framework of the European Space Agency campaign BioSAR. [J1011]

"Estimating the Driving State of Oncoming Vehicles From a Moving Platform Using Stereo Vision"

A new image-based approach for fast and robust vehicle tracking from a moving platform is presented. Position, orientation, and full motion state, including velocity, acceleration, and yaw rate of a detected vehicle, are estimated from a tracked rigid 3-D point cloud. This point cloud represents a 3-D object model and is computed by analyzing image sequences in both space and time, i.e., by fusion of stereo vision and tracked image features. Starting from an automated initial vehicle hypothesis, tracking is performed by means of an extended Kalman filter. The filter combines the knowledge about the movement of the rigid point cloud's points in the world with the dynamic model of a vehicle. Radar information is used to improve the image-based object detection at far distances. The proposed system is applied to predict the driving path of other traffic participants and currently runs at 25 Hz (640 times 480 images) on our demonstrator vehicle. [J1012]

"The Contribution of ALOS PALSAR Multipolarization and Polarimetric Data to Crop Classification"

Mapping and monitoring changes in the distribution of cropland provide information that aids sustainable approaches to agriculture and supports early warning of threats to global and regional food security. This paper tested the capability of Phased Array type L-band Synthetic Aperture Radar (SAR) (PALSAR) multipolarization and polarimetric data for crop classification. L-band results were compared with those achieved with a C-band SAR data set (ASAR and RADARSAT-1), an integrated C- and L-band data set, and a multitemporal optical data set. Using all L-band linear polarizations, corn, soybeans, cereals, and hay-pasture were classified to an overall accuracy of 70%. A more temporally rich C-band data set provided an accuracy of 80%. Larger biomass crops were well classified using the PALSAR data. C-band data were needed to accurately classify low biomass crops. With a multifrequency data set, an overall accuracy of 88.7% was reached, and many individual crops were classified to accuracies better than 90%. These results were competitive with the overall accuracy achieved using three Landsat images (88.0%). L-band parameters derived from three decomposition approaches (Cloude-Pottier, Freeman-Durden, and Krogager) produced superior crop classification accuracies relative to those achieved using the linear polarizations. Using the Krogager decomposition parameters from all three PALSAR acquisitions, an overall accuracy of 77.2% was achieved. The results reported in this paper emphasize the value of polarimetric, as well as multifrequency SAR, data for crop classification. With such a diverse capability, a SAR-only approach to crop classification becomes increasingly viable. [J1013]

"A 60 GHz Six-Port Distance Measurement System With Sub-Millimeter Accuracy"

A new compact six-port millimeter-wave distance measurement system is presented. The radar operates at the single frequency of 60 GHz and makes use of both the magnitude and phase of the measured free-space reflection coefficient to overcome the ambiguity of phase. The principle of operation, the system and experimental results are described in this letter. [J1014]

"Rapid prototyping of radar algorithms [JApplications Corner]"

Rapid prototyping of advanced signal processing algorithms is critical to developing new radars. Signal processing engineers usually use high level languages like MATLAB, IDL, or Python to develop advanced algorithms and to determine the optimal parameters for these algorithms. Many of these algorithms have very long execution times due to computational complexity and/or very large data sets, which hinders an efficient engineering development workflow. That is, signal processing engineers must wait hours, or even days, to get the results of the current algorithm, parameters, and data set before making changes and refinements for the

next iteration. In the meantime, the engineer may have thought of several more permutations that he or she wants to test. [J1015]

"Orthogonal Block Coded ECCM Schemes Against Repeat Radar Jammers"

This paper develops radar signaling schemes to combat the impact of repeat jammers on radar systems. Robustness against jammers is achieved by employing the concept of pulse diversity where the radar, at each pulse repetition interval, emits either a modified version of the previous waveform or a new waveform following a specific orthogonal structure. Two pulse coding techniques are presented; both enable the radar to separate the signals being reflected off the true targets and the false reflectors being emulated by a jammer. Simulations are used to show the validity of the introduced concepts. [J1016]

"Waveform Design for Multistatic Radar Detection"

We derive the optimal Neyman-Pearson (NP) detector and its performance, and then present a methodology for the design of the transmit signal for a multistatic radar receiver. The detector assumes a Swerling I extended target model as well as signal-dependent noise, i.e., clutter. It is shown that the NP detection performance does not immediately lead to an obvious signal design criterion so that as an alternative, a divergence criterion is proposed for signal design. A simple method for maximizing the divergence, termed the maximum marginal allocation algorithm, is presented and is guaranteed to find the global maximum. The overall approach is a generalization of previous work that determined the optimal detector and transmit signal for a monostatic radar. [J1017]

"A Generalized Approach to Multiresolution Complex SAR Signal Processing"

Multiresolution synthetic aperture radar (SAR) image formation has been proven to be beneficial in a variety of applications such as improved imaging and target detection as well as speckle reduction. SAR signal processing traditionally carried out in the Fourier domain has inherent limitations in the context of image formation at hierarchical scales. We present a generalized approach to the formation of multiresolution SAR images using biorthogonal shift-invariant discrete wavelet transform (SIDWT) in both range and azimuth directions. Particularly in azimuth, the inherent subband decomposition property of wavelet packet transform is introduced to produce multiscale complex matched filtering without involving any approximations. This generalized approach also includes the formulation of multilook processing within the discrete wavelet transform (DWT) paradigm. The efficiency of the algorithm in parallel form of execution to generate hierarchical scale SAR images is shown. Analytical results and sample imagery of diffuse backscatter are presented to validate the method. [J1018]

"Quantitative SNR Analysis for ISAR Imaging using LPFT"

This paper presents the quantitative analysis of signal-to-noise ratio (SNR) for the local polynomial Fourier transform (LPFT) used for application of inverse synthetic aperture radar (ISAR) imaging. The relationship between the LPFT and Wigner-Ville distribution (WVD) is derived and theoretical analysis on the SNR achieved by using the LPFT is given. Comparisons on the SNR performances achieved by using the LPFT, the short-time Fourier transform (STFT) and the Fourier transform (FT) are presented to illustrate the merits of using the LPFT. Measures are also taken to minimize the required computational complexity by reducing the overlap length between adjacent segments of input data. Simulation results of processing radar data show the performance improvements achieved by using the LPFT. [J1019]

"Multibaseline InSAR height estimation through joint covariance matrix fitting"

A new joint processing method based on joint covariance matrix fitting is presented for the multibaseline synthetic aperture radar interferometry. This method can make full use of the interferometric information embedded in the joint covariance matrix to estimate the terrain height without eigendecomposition and eigenspace division, and is insensitive to the rank variation of the joint signal subspace. By fitting the sample joint covariance matrix tapered with the coherence matrix, this method can work robustly with a finite sample support, which also makes it possible to recover the detail of terrain profile with a small neighbouring sample support. The results of numerical simulations demonstrate the validation of the proposed method. [J1020]

"Azimuth-invariant bistatic multichannel synthetic aperture radar for moving target detection and location"

Ground moving target indication (GMTI) is one of the most important applications of the bistatic synthetic aperture radar (SAR) system as well as the monostatic system. An algorithm for moving target detection and location is presented with an azimuth-invariant bistatic multichannel SAR, which consists of one transmitter

(channel) and multireceivers (multichannel). The algorithm is based on the discussion of the particularities of the bistatic SAR configuration including coherence improvement and clutter characteristics. Then, the corresponding compensating methods including two-dimensional range-azimuth prefiltering and bistatic differential range correction are proposed to solve these particularities. It is shown that using the compensating methods, the stationary clutter can be suppressed and the moving parameters of ground targets can be estimated accurately. Finally, simulation results demonstrate the effectiveness of the proposed algorithm. [J1021]

"ISAR imaging of manoeuvring targets with the range instantaneous chirp rate technique"

The conventional range instantaneous Doppler (RID) algorithm is a well accepted inverse synthetic aperture radar (ISAR) imaging method for manoeuvring targets. In the RID imaging, the cross-range resolution depends on the instantaneous Doppler of scatterers at the imaging instant. For a high manoeuvring target, the instantaneous Doppler of scatterers may be small at some imaging instants and the satisfactory RID images may not be obtained. On the other hand, a large instantaneous chirp rate is often present for the same scatterer at the same instant for RID imaging. In order to obtain some additional information of a manoeuvring target, a novel ISAR imaging approach, referred to as the range instantaneous chirp (RIC), is proposed based on instantaneous chirp rate of scatterer to provide cross-range resolution. Using the proposed imaging algorithm, with the same received data of RID, a RIC image is generated at the same instant with a different `view`. Therefore the RIC image may provide some additional information that is not shown in the RID image. With both the RIC and RID images, a better target recognition and identification can be achieved for high-manoeuvring targets. The proposed RIC algorithm is verified by raw radar data. [J1022]

"Coordinate Conversion and Tracking for Very Long Range Radars"

The problem of tracking with very long range radars is studied in this paper. First, the measurement conversion from a radar's r-u-v coordinate system to the Cartesian coordinate system is discussed. Although the nonlinearity of this coordinate transformation appears insignificant based on the evaluation of the bias of the converted measurements, it is shown that this nonlinearity can cause significant covariance inconsistency in the conventionally converted measurements (CM1). Since data association depends critically on filter consistency, this issue is very important. Following this, it is shown that a suitably corrected conversion (CM2) eliminates the inconsistency. Then, initialized with the converted measurements (using CM2), four Cartesian filters are evaluated. It is shown that, among these filters, the converted measurement Kalman filter with second order Taylor expansion (CM2KF) is the only one that is consistent for very long range tracking scenarios. Another two approaches, the range-direction-cosine extended Kalman filter (ruvEKF) and the unscented Kalman filter (UKF) are also evaluated and shown to suffer from consistency problems. However, the CM2KF has the disadvantage of reduced accuracy in the range direction. To fix this problem, a consistency-based modification for the standard extended Kalman filter (E1KF) is proposed. This leads to a new filtering approach, designated as measurement covariance adaptive extended Kalman filter (MCAEKF). For very long range tracking scenarios, the MCAEKF is shown to produce consistent filtering results and be able to avoid the loss of accuracy in the range direction. It is also shown that the MCAEKF meets the posterior Carmer-Rao lower bound for the scenarios considered. [J1023]

"Support Vector Machine for Multifrequency SAR Polarimetric Data Classification"

The objective of this paper is twofold: first, to assess the potential of radar data for tropical vegetation cartography and, second, to evaluate the contribution of different polarimetric indicators that can be derived from a fully polarimetric data set. Because of its ability to take numerous and heterogeneous parameters into account, such as the various polarimetric indicators under consideration, a support vector machine (SVM) algorithm is used in the classification step. The contribution of the different polarimetric indicators is estimated through a greedy forward and backward method. Results have been assessed with AIRSAR polarimetric data polarimetric data acquired over a dense tropical environment. The results are compared to those obtained with the standard Wishart approach, for single frequency and multifrequency bands. It is shown that, when radar data do not satisfy the Wishart distribution, the SVM algorithm performs much better than the Wishart approach, when applied to an optimized set of polarimetric indicators. [J1024]

"Feed-forward linearisation technique for impulse radar ultra-wideband over fibre"

The authors present the linearisation of impulse radar ultra-wideband (IR-UWB) transmission system over fibre. The radio frequency signal of IR-UWB is transmitted over 50 km of the single mode fibre (SMF) using external Mach Zehnder modulator (MZM), amplified, linearised and detected by photodetector receiver. For improving the linearity and suppressing the four-wave mixing (FWM) caused by semiconductor optical amplifier (SOA) and 50 km SMF, the system uses feed-forward technique. Link performance was evaluated for two IR-UWB signals to

suppress the FWM. The theoretical simulation results demonstrate a distortion cancellation that is produced by SOA of better than 25 dB over 1550 nm single mode optical fibre cable. In addition, the characteristic transmission of UWB pulse radio through 50 km single mode radio over fibre (RoF) system, such as BER measurements to evaluate the performance of the UWB with respect to different laser power output level, is investigated. This technique has been used to successfully transmit indirectly modulated data using laser diode at 10 GB/s light-wave transmission system. [J1025]

"Hypothesis Testing and Decision Making: Constant-False-Alarm-Rate Detection"

Detection is the first task in establishing a communication link, or tracking a target with a radar system. This is a decision-making problem, and it is performed through a hypothesis-testing procedure. Hypothesis testing is nothing but constant-false-alarm-rate (CFAR) detection. These issues are reviewed, and simple MATLABtrade codes are presented. [J1026]

"Calibration of Polarimetric PALSAR Imagery Affected by Faraday Rotation Using Polarization Orientation"

For spaceborne polarimetric synthetic aperture radar (SAR), it is important to ensure the removal of both polarimetric system distortion and the effect of Faraday rotation. This paper proposes a new calibration method to derive the system distortion using polarization orientation (PO) induced in built-up areas and applies to Phased-Array-Type L-Band SAR (PALSAR) calibration. Faraday rotation is corrected by the circular-polarization-based method from the distortion matrix (DM)-calibrated data. The derived DMs do not coincide with those by the Japan Aerospace Exploration Agency (JAXA), but our calibration results compare well to JAXA's results in PO angles and calibrator's responses. The two results satisfy polarimetric calibration requirements, and the cross-polarized isolation improves by more than 5 dB after Faraday rotation correction following DM calibration-even in the case of small Faraday rotation (-2deg to -0.5deg). The proposed method is robust to noise and is useful when using an area of mixed polarimetric response for calibration. This method is also applicable to a large crosstalk system and the case of large Faraday rotation. [J1027]

"Separation of SSR Signals by Array Processing in Multilateration Systems"

Location and identification of cooperating aircraft in the airport area (and beyond) may be implemented by multilateration (MLAT) systems using the secondary surveillance radar (SSR) mode S signals. Most of these signals, spontaneously emitted from on-board mode S transponders at a fixed carrier frequency, arrive randomly at the receiving station, as well as many mode A/C replies from legacy transponders still in use. Several SSR signals are, then, overlapped in multiple aircraft situations. Therefore, the aim of this work is the separation of overlapped SSR signals, i.e., signals superimposed in time at receiving stations. We improve the MLAT receiving station by replacing the single antenna by an array of m elements and using array signal processing techniques. In the literature, several algorithms address the general source separation problem, but a very few of them are specifically designed for a mixture of overlapping SSR replies. Unfortunately, all of them have either some shortcomings, or an expensive computational cost, or no simple practical implementation. In this paper, we use the time sparsity property of the sources to propose more reliable, simpler, and more effective algorithms based on projection techniques to separate multiple SSR signals. Real recorded signals in a live environment are used to demonstrate the effectiveness of our method. [J1028]

"Space-borne technology and inversion techniques for radar"

This presents recent progress of the state-of-the-art of space-borne radar technology in case of either earth-orbiting or planetary-orbiting satellites and space probes, respectively. In addition to that, recent progress is also discussed concerning specific inversion techniques to evaluate radar measurements; i.e., the art of deriving the relevant physical quantities to be determined such as terrain and depth profiles for planetary surface and/or subsurface structures ((3D)-profiles) from radar data measured depending on signal frequency, aspect angle, polarization, etc., as a function of time. [J1029]

"Maritime border control multisensor system"

This focuses on the classification task performed into a multi-sensor system for the coastal surveillance. The system is composed of two platforms of sensors: a land-based platform equipped with a land based radar, an Automatic Identification System (AIS) and an infrared camera (IR); an airborne platform carrying an airborne radar that can operate in a spotlight Synthetic Aperture Radar (SAR) mode, a video camera, and a second IR camera. The tasks performed by the system are the detection, tracking, identification, and classification of multiple targets, the evaluation of their threat level, and the selection of an intervention on them. The classification algorithm implemented inside the system exploits an analytical approach based on the confusion

matrix (CM) of the imaging sensors that belong to the system. Some measures of effectiveness (MoE) of the system are evaluated, considering both cases where an ideal error-free classification process and a non-ideal classification process are performed. [J1030]

"Azimuth Phase Center Adaptation on Transmit for High-Resolution Wide-Swath SAR Imaging"

Synthetic aperture radar (SAR) systems with multiple receive channels allow for high-resolution wide-swath imaging thus overcoming a fundamental limitation of conventional single-aperture SAR. By using multiple apertures in azimuth, additional samples are received for each transmitted pulse. This allows for a reduced pulse repetition frequency (PRF) thereby enabling a wider swath. However, a nonoptimum PRF is associated with a nonuniform sample spacing in azimuth and needs to be compensated by a multichannel reconstruction algorithm. For strong deviations from the optimum PRF, the inverse character of such an algorithm might result in a degraded performance. This can be overcome by an innovative advanced transmit antenna architecture which allows for a pulse-to-pulse shift of the phase center. Such an antenna enables the adaptive adjustment of the system's phase center positions to the respective PRF, thereby ensuring constant performance over a clearly extended PRF range. In particular, in combination with conventional multichannel processing strategies, this technique represents the next step toward a fully active multiple-input multiple-output (MIMO) SAR and has a great potential for future systems. [J1031]

"Airborne Ku-Band Polarimetric Radar Remote Sensing of Terrestrial Snow Cover"

Characteristics of the Ku-band polarimetric scatterometer (POLSCAT) data acquired from five sets of aircraft flights in the winter months of 2006-2008 for the second Cold Land Processes Experiment (CLPX-II) in Colorado are described in this paper. The data showed the response of the Ku-band radar echoes to snowpack changes for various types of background vegetation in the study site in north central Colorado. We observed about 0.15-0.5-dB increases in backscatter for every 1 cm of snow-water-equivalent (SWE) accumulation for areas with short vegetation (sagebrush and pasture). The region with the smaller amount of biomass, signified by the backscatter in November, seemed to have the stronger backscatter response to SWE in decibels. The data also showed the impact of surface hoar growth and freeze/thaw cycles, which created large snow-grain sizes, ice crust layers, and ice lenses and consequently increased the radar signals by a few decibels. The copolarized HH/VV backscatter ratio seems to indicate double-bounce scattering between the ground surface and snow or vegetation. The cross-polarized backscatter [vertical-horizontal (VH)] showed not only the influence of vegetation but also the strong response to snow accumulation. The observed HV/VV ratio suggests the importance of multiple scattering or nonspherical scattering geometry of snow grain in the dense-media radiative transfer scattering model. Comparison of the POLSCAT and QuikSCAT data was made and confirmed the effects of mixed terrain covers in the coarse-resolution QuikSCAT data. [J1032]

"Gaussian process regressors for multiuser detection in DS-CDMA systems"

In this paper we present Gaussian processes for Regression (GPR) as a novel detector for CDMA digital communications. Particularly, we propose GPR for constructing analytical nonlinear multiuser detectors in CDMA communication systems. GPR can easily compute the parameters that describe its nonlinearities by maximum likelihood. Thereby, no cross-validation is needed, as it is typically used in nonlinear estimation procedures. The GPR solution is analytical, given its parameters, and it does not need to solve an optimization problem for building the nonlinear estimator. These properties provide fast and accurate learning, two major issues in digital communications. The GPR with a linear decision function can be understood as a regularized MMSE detector, in which the regularization parameter is optimally set. We also show the GPR receiver to be a straightforward nonlinear extension of the linear minimum mean square error (MMSE) criterion, widely used in the design of these receivers. We argue the benefits of this new approach in short codes CDMA systems where little information on the users' codes, users' amplitudes or the channel is available. The paper includes some experiments to show that GPR outperforms linear (MMSE) and nonlinear (SVM) state-ofthe- art solutions. [J1033]

"L-Band Radar Estimation of Forest Attenuation for Active/Passive Soil Moisture Inversion"

In the radiometric sensing of soil moisture through a forest canopy, knowledge of canopy attenuation is required. Active sensors have the potential of providing this information since the backscatter signals are more sensitive to forest structure. In this paper, a new radar technique is presented for estimating canopy attenuation. The technique employs details found in a transient solution where the canopy (volume-scattering) and the tree-ground (double-interaction) effects appear at different times in the return signal. The influence that these effects have on the expected time-domain response of a forest stand is characterized through numerical simulations. A coherent forest scattering model, based on a Monte Carlo simulation, is developed to calculate the transient

response from distributed scatterers over a rough surface. The forest transient-response model for linear copolarized cases is validated with the microwave deciduous tree data acquired by the Combined Radar/Radiometer (ComRAD) system. The attenuation algorithm is applicable when the forest height is sufficient to separate the components of the radar backscatter transient response. The frequency correlation functions of double-interaction and volume-scattering returns are normalized after being separated in the time domain. This ratio simply provides a physically based system of equations with reduced parameterizations for the forest canopy. Finally, the technique is used with ComRAD L-band stepped-frequency data to evaluate its performance under various physical conditions. [J1034]

"Direction finding of MIMO radar through ESPRIT and Kalman filter"

A novel method employing an ESPRIT and Kalman filter is proposed for the one-dimensional direction finding problem of MIMO radar. The rotational invariance among the multiple equivalent virtual subarrays of MIMO radar is exploited to derive multiple estimates of the direction of each target through ESPRIT. The multiple estimates of each target are fused through a Kalman filter to refine the accuracy of estimation. Numerical examples demonstrate the effectiveness of the proposed method. [J1035]

"Joint Regularization of Phase and Amplitude of InSAR Data: Application to 3-D Reconstruction"

Interferometric synthetic aperture radar (SAR) images suffer from a strong noise, and their regularization is often a prerequisite for successful use of their information. Independently of the unwrapping problem, interferometric phase denoising is a difficult task due to shadows and discontinuities. In this paper, we propose to jointly filter phase and amplitude data in a Markovian framework. The regularization term is expressed by the minimization of the total variation and may combine different information (phase, amplitude, optical data). First, a fast and approximate optimization algorithm for vectorial data is briefly presented. Then, two applications are described. The first one is a direct application of this algorithm for 3-D reconstruction in urban areas with very high resolution images. The second one is an adaptation of this framework to the fusion of SAR and optical data. Results on aerial SAR images are presented. [J1036]

"Generalized Frequency-Domain SAR Processing"

The range-Doppler algorithm and the chirp-scaling algorithm (CSA) process synthetic aperture radar (SAR) data with approximations to ideal SAR processing. These approximations are invalid for data from systems with wide beamwidths, large bandwidths, and/or low center frequencies. While simple and efficient, these frequency-domain methods are thus limited by the SAR parameters. This paper explores these limits and proposes a generalized chirp-scaling approach for extending the utility of frequency-domain processing. We demonstrate how different order approximations of the SAR signal in the 2-D frequency domain affect image focusing for varying SAR parameters. From these results, a guideline is set forth, which suggests the required order of approximation terms for proper focusing. A proposed generalized frequency-domain processing approach is derived. This method is an efficient arbitrary-order CSA that processes the data using the appropriate number of approximation terms. The new method is demonstrated using simulated data. [J1037]

"Signatures of ALOS PALSAR L-Band Backscatter in Swedish Forest"

The Phased Array type L-band Synthetic Aperture Radar onboard the Advanced Land Observing Satellite has, since its launch, been acquiring an extensive data set of images over two forest test sites in Sweden. The sites of Remningstorp (Lat. 58deg30' N, Long. 13deg40' E) in the south and Krycklan (Lat. 64deg14' N, Long. 19deg50' E) in the north of Sweden are characterized by hemiboreal and boreal forests, respectively. In this paper, we have investigated the signatures of standwise backscatter measurements from forests with different growth stages in relation to polarization, environmental conditions, image viewing geometry, and spatial resolution. The HV backscatter presented stronger sensitivity to the forest growth stage than the HH and VV backscatter. Under unfrozen conditions, the dynamic range of fine-beam data acquired at 34.3deg was 8-9 dB for the HV polarization and 6-7 dB for the HH polarization. At 21.5deg, in the polarimetric mode, the dynamic range was 6, 7, and 9 dB at VV, HH, and HV polarizations, respectively. Regardless of the specific polarization, the backscatter was temporally consistent under unfrozen conditions, with a small increase of backscatter in regrowing young forest for wet conditions. Under thawing and frozen conditions, repeated measurements were available only for the HH backscatter at 34.3deg. For thawing conditions, the backscatter level was similar to the unfrozen conditions even though the signatures differed depending on temperature dynamics, snow-cover properties, and precipitation. Under frozen conditions, the signatures varied depending on temperature. For images acquired when the temperature was well below the freezing point, the backscatter was low, and the dynamic range was small (2-4 dB); nonetheless, the measurements were consistent. Images acquired when temperature was close to the freezing point presented a behavior similar to unfrozen conditions. The sensitivity

of the backscatter to the image viewing geometry for d--ifferent growth stages was studied for data acquired under dry unfrozen conditions. The backscatter difference increased for increasing look angle because of the increase in volume scattering and the decrease of ground-surface backscatter. The largest difference was observed at 41.5deg with 2.5-4-dB difference for the HH and 4-5-dB difference for the HV case. Loss of spatial resolution (20-50 m) did not have any effect on the backscatter signatures in Krycklan, whereas in Remningstorp, the smallest stands were affected. [J1038]

"Range-Spread Target Detection Based on Cross Time-Frequency Distribution Features of Two Adjacent Received Signals"

High resolution radars (HRRs) transmit a wideband signal to achieve a high range resolution. A target is considered as composed of multiple scatterers, which occupy or spread in multiple radar range cells with several scatterers in each cell. Therefore, the reflection of a target spreads in multiple range cells in the received signal, which contains more information of target than that obtained from low resolution radars. The target in high resolution radar systems is a range-spread target. The range-spreading or echo features of target are utilized for target detection and identification. The echoes of target are convolutions of transmitted signals with target range-scattering functions dependent on the gesture of target to the line of radar sight. A single echo is used in the conventional detection. It is difficult for target detection and identification in low signal-to-noise ratio (SNR) condition. In this paper, we propose a new range-spread target detection scheme exploiting the image features of cross time-frequency distribution (TFD) of a pair of adjacent received signals. After dechirping, the received signal reflected from target consists of multiple sinusoidal components due to its multiple scatterers when a linear frequency modulated (LFM) signal is transmitted from radar. Some regular image patterns or features of target appear in the cross TFD of two adjacent received signals, while the cross TFD of two independent Gaussian noises does not show such patterns. The cross TFD features are exploited in the proposed scheme. Three steps are composed in the proposed scheme. Firstly, a cross smoothed-pseudo Wigner-Ville distribution (CSPWVD) is made for two adjacent received signals to generate a two-dimensional (2-D) TF image. Then, some regular geometric patterns are detected and extracted from the image. At last, two features of the extracted geometric patterns are jointly utilized to detect target. The proposed algorithm is verified by using raw radar data.--It outperforms the conventional detection methods. [J1039]

"PALSAR Radiometric and Geometric Calibration"

This paper summarizes the results obtained from geometric and radiometric calibrations of the Phased-Array L-Band Synthetic Aperture Radar (PALSAR) on the Advanced Land Observing Satellite, which has been in space for three years. All of the imaging modes of the PALSAR, i.e., single, dual, and full polarimetric strip modes and scanning synthetic aperture radar (SCANSAR), were calibrated and validated using a total of 572 calibration points collected worldwide and distributed targets selected primarily from the Amazon forest. Through raw-data characterization, antenna-pattern estimation using the distributed target data, and polarimetric calibration using the Faraday rotation-free area in the Amazon, we performed the PALSAR radiometric and geometric calibrations and confirmed that the geometric accuracy of the strip mode is 9.7-m root mean square (rms), the geometric accuracy of SCANSAR is 70 m, and the radiometric accuracy is 0.76 dB from a corner-reflector analysis and 0.22 dB from the Amazon data analysis (standard deviation). Polarimetric calibration was successful, resulting in a VV/HH amplitude balance of 1.013 (0.0561 dB) with a standard deviation of 0.062 and a phase balance of 0.612deg with a standard deviation of 2.66deg . [J1040]

"Position Correction Using Echoes From a Navigation Fix for Synthetic Aperture Sonar Imaging"

In synthetic aperture sonar (SAS), the platform position must be known sufficiently accurately for signals to be added coherently along the synthetic aperture. Often, the onboard navigation system is insufficiently accurate by itself, so corrections are needed. A well-known method is the displaced phase center antenna (DPCA) procedure for correcting platform position using seabed echoes. DPCA methods have the advantage of insensitivity to changing interference patterns, moving specular reflection, and changing occlusion, with aspect. However, when seabed echoes are unusable, either because they are too weak, or because they are corrupted by multipath, the seabed DCPA method may fail. Therefore, we present an alternative DPCA method using sonar echoes from a suitable navigation fix, based on an object detected after standard beamforming. In our proposed system, look angle is obtained by tracking the centroid of the rectified image of the fix object. When the standard DPCA correction equations are modified for a fixed reflector, it turns out that they provide incremental range and look-angle errors, precisely the values required when the target itself is used as the navigation fix. Moreover, the values obtained are then self-compensating for errors in estimating seabed depth or forward motion of the platform. The navigation fix is selected by bracketing in range, and beamforming overlapping subsets of the receiver array. In this paper, we present experimental results at transmitter frequencies of 25 and 100 kHz where our method enabled well-focused SAS images to be generated with little recourse to other navigation

information. Hence, SAS can be carried out, even when a sophisticated inertial navigation system (INS) is not available. [J1041]

"Absolute Phase-Based Distance Measurement for Industrial Monitoring Systems"

In this paper, principal considerations for a high accuracy millimeter wave (mmw) radar distance measurement system applicable to be used in harsh industrial environments are presented. The system is based on continuous wave (CW) measurement of the reflection coefficient and interpretation of the signal phase. The ambiguity of the phase is overcome by means of a multiple frequency technique. For absolute distance determination, an online calibration procedure is applied. The applicability of the system is underlined by a laboratory demonstrator measurement. [J1042]

"Multiscale Change Detection in Multitemporal Satellite Images"

In this letter, we propose a novel technique for unsupervised change detection in multitemporal satellite images. The difference image which is computed from multitemporal images acquired on the same geographical area at two different time instances is decomposed using S-levels undecimated discrete wavelet transform (UDWT). For each pixel in the difference image, a multiscale feature vector is extracted using the subbands of the UDWT decomposition and the difference image itself. The final change detection map is achieved by clustering the multiscale feature vectors using k-means algorithm into two disjoint classes: changed and unchanged. Experimental results confirm the efficacy of the proposed approach on both optical and synthetic aperture radar images. [J1043]

"Iterative Weighted Maximum Likelihood Denoising With Probabilistic Patch-Based Weights"

Image denoising is an important problem in image processing since noise may interfere with visual or automatic interpretation. This paper presents a new approach for image denoising in the case of a known uncorrelated noise model. The proposed filter is an extension of the nonlocal means (NL means) algorithm introduced by Buades, which performs a weighted average of the values of similar pixels. Pixel similarity is defined in NL means as the Euclidean distance between patches (rectangular windows centered on each two pixels). In this paper, a more general and statistically grounded similarity criterion is proposed which depends on the noise distribution model. The denoising process is expressed as a weighted maximum likelihood estimation problem where the weights are derived in a data-driven way. These weights can be iteratively refined based on both the similarity between noisy patches and the similarity of patches extracted from the previous estimate. We show that this iterative process noticeably improves the denoising performance, especially in the case of low signal-to-noise ratio images such as synthetic aperture radar (SAR) images. Numerical experiments illustrate that the technique can be successfully applied to the classical case of additive Gaussian noise but also to cases such as multiplicative speckle noise. The proposed denoising technique seems to improve on the state of the art performance in that latter case. [J1044]

"Comparison of the ASI Ice Concentration Algorithm With Landsat-7 ETM+ and SAR Imagery"

Continuous monitoring of sea ice and its changes is mainly done by passive microwave sensors on satellites. One frequently used technique of retrieving sea-ice concentrations is the Arctic Radiation and Turbulence Interaction STudy Sea Ice (ASI) algorithm, which uses the near-90-GHz channels, here those of the Advanced Microwave Scanning Radiometer-Earth Observing System to calculate sea-ice concentrations. The ASI ice concentrations are compared with ice concentrations derived from the following: 1) the multispectral imager Enhanced Thematic Mapper Plus operating on Landsat and 2) from Envisat and Radarsat SAR images. In this paper, we focus on marginal ice zones, as the ice concentrations in those regions are in general observed with higher errors. First-year ice (bias: -1%-0% and rms error: 1%-4%) and young ice (bias: -4%-0% and rms error: 3%-9%) are fairly well recognized with little underestimation of ASI ice concentrations with respect to Landsat ice concentrations. New ice is identified with less accuracy by the ASI algorithm (bias: -16%-9% and rms error: 18.3%-26.2%). Averaged over all ice types, the bias ranges between -8.4% and 4.5%, and the rms error ranges between 2.0% and 17.4%. Discrepancies mainly occur in polynya areas (underestimation by ASI) and along the ice edge (overestimation by ASI). The results of the ASI-SAR comparison yield contrasting results. ASI underestimates the ice concentrations near the ice edge but overestimates them in some interior areas (bias: -2.9%-2.5% and rms error: 16.9%-20.1%). The discrepancies between both comparisons may be due to the different interaction mechanisms of the different sensor types, particularly with the newly formed ice. [J1045]

"MST Radar Signal Processing Using Wavelet-Based Denoising"

Atmospheric signal processing is of interest to many scientists, where there is scope for the development of new and efficient tools for cleaning the spectrum, detection, and estimation of parameters like zonal (U), meridional

(V), wind speed (W), etc. This letter deals with a signal processing technique for the estimation of the aforementioned parameters, based on the wavelets, by analyzing the mesosphere-stratosphere-troposphere radar data that are backscattered from the atmosphere at high altitudes and severe weather conditions with low signal-to-noise ratio. The proposed algorithm is self-consistent in detecting wind speeds up to a height of 18 km, in contrast to the existing method which estimates the Doppler manually and fails at higher altitudes. The results have been validated using the Global Positioning System sonde data. [J1046]

"Adaptive beamforming for high-frequency over-the-horizon passive radar"

Target detection and tracking systems using emitters of opportunity have received significant interest recently, especially those which exploit VHF and UHF broadcasts as signal sources in so-called passive radar systems. Here, the authors discuss an experimental system in the high-frequency (HF) band, where due to long-distance ionospheric propagation of radio waves in the 3-30-MHz spectrum, the illuminator may be located well beyond the line-of-sight. In this study, live data was recorded by a high dynamic range multi-channel digital receiver connected to a two-dimensional (L-shaped) antenna array, and signals from an uncooperative HF over-the-horizon (OTH) radar transmitter have been captured and analysed. As a preliminary step towards the development of a general HF-OTH passive radar system, the scope of this work is to compare the performance of conventional and adaptive spatial processing techniques in terms of their ability to cancel direct-wave interference and protect useful signal echoes to detect a small cooperative aircraft target. In particular, an alternative adaptive beamforming method specifically tailored to this application is proposed, and its practical performance is compared with classical and standard adaptive beamforming approaches. GPS data measured on-board the cooperative aircraft provided accurate ground truth of the flight path, enabling target profiles in bi-static range, Doppler frequency and direction-of-arrival (azimuth/elevation) to be calculated as a function of time. This information permitted the different processing schemes to be evaluated with a high degree of confidence. The experimental system and live data analysed are exclusively from the HF Radar program of the Defence Science and Technology Organisation (DSTO), Australia. [J1047]

"Handling partially calibrated conformal antenna arrays in rangedependence compensation for airborne bistatic spacetime adaptive processing radar"

The authors consider space-time adaptive processing (STAP) when the radar returns are recorded by a conformal antenna array (CAA). The statistics of the secondary data snapshots used to estimate the optimum weight vector are not identically distributed with respect to range, thus preventing the customary STAP processor from achieving its optimum performance. The compensation of the range dependence of the secondary data requires precise knowledge of the array response for any direction of arrival (DOA), and, thus, of the spatial steering vectors (SVs). The authors propose a novel registration-based range-dependence compensation algorithm that gives an accurate estimate of the interference-plus-noise covariance matrix under the hypotheses that calibrated spatial SVs are available only for a small set of DOAs, and that the errors in the model giving the true spatial SV for each DOA are DOA dependent. The performance in terms of signal-to-interference-plus-noise ratio loss is promising. [J1048]

"Adaptive ground clutter suppression for conformal array radar systems"

Conformal arrays (CFAs) possess certain desirable characteristics for deployment on unmanned aerial vehicles and other payload-limited platforms. However, the CFA non-planar geometry induces clutter non-stationarity, resulting in elevated signal-to-interference-plus-noise ratio (SINR) loss when applying conventional space-time adaptive processing (STAP) algorithms. Non-stationary clutter leads to covariance matrix estimation error and, consequently, an erroneous STAP frequency response. In this study, the authors examine two practical conformal antenna configurations: a belly-mounted canoe and a nose-mounted, chined shape. Using high-fidelity signal models, the authors show traditional STAP losses in excess of 10-dB because of the effects of clutter non-stationarity. The authors then investigate a number of ameliorating techniques compatible with standard STAP implementation, including localised processing, localised processing with time-varying weights, equivalent uniform linear array transformation, angle-Doppler warping and higher-order angle-Doppler warping. The authors demonstrate very good performance for the higher-order angle-Doppler warping method applied to the chined radome shape, with peak adaptive SINR losses reduced from nearly 16-dB for the uncompensated case to 3-dB of loss consistent with performance attainable in a homogeneous clutter environment. The authors also find good performance for three-dimensional angle-Doppler warping over azimuth, elevation and Doppler when applied to the tapered canoe shape, with uncompensated losses of roughly 14-dB reduced to 3-dB, again a level compatible with STAP applied in a homogeneous clutter environment. The authors thus show that CFA STAP can yield performance similar to that of a conventional planar array when using appropriate compensation methods. [J1049]

"Linear and adaptive spaceborne threedimensional SAR tomography: a comparison on real data"

Three-dimensional (3-D) synthetic aperture radar (SAR) imaging is a recent technique, based on coherent SAR data combination, and aims to obtain a full 3-D analysis in space. It is a multibaseline extension of the SAR interferometry concept and offers new options for the analysis and monitoring of ground scenes by means of the capability of separating the scattering phenomena along the height dimension. In this work, the authors summarise and extend the results obtained by processing real ERS satellite urban data characterised by a long time span of acquisition and non-uniformly spaced satellite passes, comparing the performance in height focusing obtained with a singular value decomposition (SVD)-based method and adaptive beamforming. [J1050]

"A Lossy Dielectric-Ring Loaded Waveguide With Suppressed Periodicity for Gyro-TWTs Applications"

A dielectric-loaded (DL) waveguide is an attractive possibility for interaction circuits with high-power sources in the millimeter-wave regime down to tenths of millimeters, particularly for gyrotron-traveling-wave-tube amplifiers (gyro-TWTs). We present results on a systematic investigation of the influence of the periodically loaded lossy dielectric on the propagation characteristics of the operating modes, which reveals that a complex mode in the periodic system can be mapped to a corresponding mode in an empty waveguide or a uniform DL waveguide. Dielectric losses not only induce modal transitions between different modes with similar field structures and close phase velocities in the uniform system but also unify the discrete mode spectrum into a continuous spectrum in the periodic system. Since the lossy dielectric functions as a power sink, the higher order Bloch harmonic components arising from the structural periodicity are suppressed, and the mode spectrum of the lossy periodic system degenerates into that of an empty waveguide. This alleviates the potential danger of spurious oscillations induced by the higher order harmonic components, making the periodic lossy DL waveguide promising in a high-power millimeter-wave gyro-TWT. [J1051]

"Estimating Spatiotemporal Ground Deformation With Improved Persistent-Scatterer Radar Interferometry"

Synthetic aperture radar interferometry has been applied widely in recent years to ground deformation monitoring although difficulties are often encountered when applying the technology, among which the spatial and temporal decorrelation and atmospheric artifacts are the most prominent. The persistent-scatterer interferometric synthetic aperture radar (PS-InSAR) technique has overcome some of the difficulties by focusing only on the temporally coherent radar targets in a time series of synthetic aperture radar (SAR) images. This paper presents an improved PS-InSAR technique by introducing PS-neighborhood networking and empirical mode decomposition (EMD) approaches in the PS-InSAR solution. Linear deformation rates and topographic errors are estimated based on a least squares method, while the nonlinear deformation and atmospheric signals are computed by singular value decomposition and the EMD method. An area in Phoenix, AZ, is used as a test site to determine its historical subsidence with 39 C-band SAR images acquired by European Remote Sensing 1 and 2 satellites from 1992 to 2000. [J1052]

"Instantaneous Microwave Frequency Measurement With Improved Measurement Range and Resolution Based on Simultaneous Phase Modulation and Intensity Modulation"

A novel approach to implementing instantaneous microwave frequency measurement based on simultaneous optical phase modulation and intensity modulation with improved measurement range and resolution is proposed and experimentally demonstrated. The simultaneous optical phase modulation and intensity modulation are implemented using a polarization modulator (PolM) in conjunction with an optical polarizer. The phase- and intensity-modulated optical signals are then sent to a dispersive element, to introduce chromatic dispersions, which results in two complementary dispersion-induced power penalty functions. The ratio between the two power penalty functions has a unique relationship with the microwave frequency. Therefore, by measuring the microwave powers and calculating the power ratio, the microwave frequency can be estimated. Thanks to the complementary nature of the power penalty functions, a power ratio having a faster change rate versus the input frequency, i.e., a greater first-order derivative, is resulted, which ensures an improved measurement range and resolution. The proposed approach for microwave frequency measurement of a continuous-wave and a pulsed microwave signal is experimentally investigated. A frequency measurement range as large as 17 GHz with a measurement resolution of plusmn 0.2 GHz for a continuous-wave microwave signal and plusmn0.5 GHz for a pulsed microwave signal is achieved. [J1053]

"Waveform design in signal-dependent interference and application to target recognition with multiple transmissions"

The authors present illumination waveforms matched to stochastic targets in the presence of signal-dependent interference. The waveforms are formed by SNR and mutual information (MI) optimisation. We also use these waveforms in cognitive radar (CR) target identification application. In this application, the radar system attempts to identify a deterministic or random target using multiple transmissions. These transmissions are adaptively modified in response to previously received echoes. In addition, the authors present a new multi-band application of the CR platform. [J1054]

"MEMS tomographic imaging system simulation"

This describes a simulation architecture used to simulate an ultra-narrowband radar tomographic imaging (UNBRaTI) system. The work is being performed at Rochester Institute of Technology. This lays the groundwork for an effort to develop a systems level approach for the simulation and analysis of an UNBRaTI system using traditional radio frequency (RF) components as well as micro-electro-mechanical systems (MEMS)-based components. The utility of the approach is its ability to apply sound systems engineering principles and techniques to compare and contrast traditional RF components with MEMS-based components and their effects on system level performance. The simulation has been architected for ease of scalability in order to analyze basic to complex system configurations. [J1055]

"Distributed weather radar using X-band active arrays"

Dense networks of short-range radars capable of mapping storms and detecting atmospheric and airborne hazards are described. Comprised of physically small, low-power antennas, these networks defeat the Earth curvature blockage that limits today's long-range radar networks and enable high resolution views that extend from the lower-troposphere to the tops of storms. The networks are comprised of 1-meter antennas that transmit 10's of W peak power and are capable of high-speed electronic beam-steering. A system architecture is described that maximizes the value accrued to users of radar data through utility functions that specify dynamic, optimal allocation of resources in response to the needs of multiple end-users and associated information retrieval algorithms. [J1056]

"Analysis of the Main Scattering Mechanisms in Forested Areas: An Integral Representation Approach for Monostatic Radar Configurations"

In this paper, a coherent forest scattering model based on the electric-field integral representation is developed. This model gives the scattered field by the forest, resulting from the interaction of an electromagnetic plane wave with its main elements (trunks, branches, and plane ground) in a frequency range of 100 to 400 MHz. The Method of Moments is used to solve the electric-field integral equation. In our treatment, there are three possible scattering mechanisms that contribute to the scattered field defined as follows: 1) single-; 2) double-; and 3) triple-bounce scattering mechanisms. The internal fields inside the tree trunks and branches are calculated by considering all of the multiple-scattering interactions within the forest. Our model is then constructed by coherently summing the three scattering mechanisms previously given. We can also obtain an approximate result by ignoring some or all of the multiple-scattering interactions in the calculation of internal fields inside the trees. The aim of this paper is, first, to determine the relative contribution of each scattering mechanism to the total scattered field, followed by the relative contribution of tree-trunk and branch scattering responses to the total scattering field, and, finally, the multiple-scattering interaction effects on the total backscattered field. [J1057]

"Adaptive path planning for VTOL-UAVs"

This describes the development of path planning algorithms of a small unmanned four-rotor helicopter. A powerful simulation environment of the whole UAV system-including the characteristics of the important ranging sensors for collision avoidance was developed. This is essential for developing, testing, and verifying of the algorithms. Different collision avoidance strategies for VTOL-UAVs are presented. Enhancements and miniaturization will offer more powerful sensor technologies regarding size, range, and power in the future. Very promising are improvements of sensor modules and new technologies like three-dimensional LASER range-finder, PMD sensors, RADAR range-finder, and stereo camera tracking system. Because of the general high level simulation tool introduced herein they can be easily validated and tested without the need and effort of a real hardware implementation. The results showed that adaptive path planning, including collision avoidance, is already applicable on-board small UAV vehicles. With the mentioned new sensor technologies and more calculation power, further improvements like advanced collision notice and global path planning on-board small UAVs are attainable. [J1058]

"Target localisation techniques and tools for multiple-input multiple-output radar"

This study presents a comparative study of coherent and non-coherent target localisation techniques for multiple-

input multiple-output (MIMO) radar systems with widely distributed elements. Performance is evaluated based on closed-form solutions developed for the best linear unbiased estimator (BLUE) for each of the localisation methods. These estimators afford insights into the relation between radar locations, target location and localisation accuracy. In particular, the means squared error of the BLUE is factored into a term dependent on signal and processing characteristics and a term dependent on sensor locations. The latter is referred to as geometric dilution of precision (GDOP). The best achievable accuracy for the coherent case is obtained, and a comparative study with the non-coherent case is presented. MIMO radar systems with coherent processing are shown to benefit from a gain because of coherent processing among sensors. This gain is referred to as coherent localisation gain, and it is proportional to the ratio of the signal carrier frequency to the effective bandwidth (a large ratio for typical signals). The footprint of multiple transmit/receive sensors results in a gain, referred to as MIMO gain, for both processing techniques. The MIMO gain is proportional to the product of the number of transmitting and receiving sensors. Analysis of the MIMO gain through the use of GDOP contour maps demonstrate the achievable accuracy at various target locations for a given layout of sensors. [J1059]

"Multiple-input multiple-output over-thehorizon radar: experimental results"

Results from an experiment that applied one class of multiple-input multiple-output (MIMO) waveform techniques to over-the-horizon radar (OTHR) are reported. The experiment objective was to demonstrate that adaptive transmitter beamforming could be used in an appropriately design radar to reject spatially discrete Doppler-spread clutter. In the particular MIMO radar architecture that the authors call non-causal transmit beamforming, conventional or adaptive transmitter beamforming occurs following waveform transmission, propagation, scatter from targets and clutter sources, return propagation and finally signal reception. In the case reported herein spatially discrete clutter was successfully rejected to the noise floor of the radar return with rejection in excess of 35 dB achieved using common adaptive algorithms and straightforward training data selection. As part of the rejection algorithm the transmitted waveform direction-of-departure (DOD) from the transmitter array to the target was estimated and used as the preserved steer direction in the adaptive beamformer. The DOD estimates agree well with the geometrically determined true values. The demonstration of non-causal transmit beamforming suggests that it will be possible to create multiple simultaneous adaptive range-dependent transmitter beams with an appropriately designed OTHR. This has several applications including for the mitigation of Doppler-spread clutter. [J1060]

"60 GHz FM-CWR Using NRD guide for distance estimation"

An FM-CW radar front-end was fabricated in an integrated manner at 60 GHz by using the NRD guide. The main emphasis was placed on compactness in size and high-precise operation in performance. The fabricated radar consists of an FM Gunn oscillator, a balanced mixer, and a planar antenna fed by a leaky NRD guide with a mechanically beam-scanning performance. All circuit components and the antenna were contained in a compact housing of 170 times 140 mm in area and 25 mm in thickness, and thus, a thin type of millimeter-wave radar front-end was successfully developed. Moreover, an error of distance estimation was measured to be less than a distance of 0.7 m. [J1061]

"Spectral Difference Between Microwave Radar and Microwave-Induced Thermoacoustic Signals"

This letter presents a spectral content comparison of the signals generated in the microwave radar (MR) and microwave-induced thermoacoustic (MIT) imaging systems. Two physical processes occur when microwave interacts with a lossy dielectric object. First, due to the contrast in the complex permittivity between the embedded object and background medium, reflection of microwave energy occurs at the interface. Second, due to the contrast in the absorption coefficient between the object and background medium and the consequent thermal expansion, microwave induces an acoustic wave. As a method of comparison between the inputs and outputs of the MR and MIT processes, we define the MR and MIT channels. We use a two-dimensional (2-D) example to demonstrate that the MR channel over the ultrawideband (UWB) spectrum from 3.1 to 10.6 GHz manifests different fading from the MIT channel over the ultrasonic spectrum from 0.32 to 1.10 MHz. The two output signals are distinctive, but they are co-registered to the same object. Hence, using the information provided by both could enhance the imaging modality. We apply this dual-physics scheme in the context of breast tumor detection. [J1062]

"Co-channel interference suppression by time and range adaptive processing in bistatic high-frequency surface wave synthesis impulse and aperture radar"

Intense co-channel interference (CCI) severely depresses the target detection in high-frequency surface wave radar (HFSWR). In this study, the CCI cancellation algorithm by time and range adaptive processing is proposed for a novel HFSWR-bistatic HF surface wave synthesis impulse and aperture radar. With the real data, the

interference is firstly modelled and then its features are investigated. The analyses show that the same interference prevails over a few but different bins through different channels, whereas the echoes are relatively weak and exist in all bins; in range domain, however, the interference takes over all the bins including positive and negative bins and will spread over the same and considerable Doppler area through different channels, whereas the echoes appear only in partially positive bins. On the basis of the features, the interference covariance matrix can be obtained by selecting the samples whose average power is much higher than that of the others in time domain and in range domain; the samples from either or both of beyond the detectable bins and negative bins can be selected for training. The interference can be cancelled by projecting the polluted data into the orthogonal subspace, constructing the projecting matrix with the eigenvectors associated with large eigenvalues of the covariance matrix. Finally, the segment handling and samples requirement are also discussed for reducing the computation burden. The experimental results are provided to demonstrate the performance of the method. [J1063]

"Wideband multipath rejection for shallow water synthetic aperture sonar imaging"

Synthetic aperture sonar (SAS) is an emerging technology for seafloor imaging, which has an appealing property of range- and frequency-independent spatial processing resolution. However, for a low-frequency SAS system operated in shallow water environments, there are often strong sea surface and bottom reflected multipath components that interfere with the desired echo signals. Based upon a small vertically displaced hydrophone array, several spatial processing algorithms have been proposed for multipath reduction. Most of these algorithms, however, are only applicable to narrowband signals, whereas wideband signals are usually used in low-to-medium-frequency SAS systems in order to achieve a high range resolution. This paper presents a steered robust Capon beamforming (SRCB) approach, and applies the approach, together with the data-independent delay-and-sum beamforming and the conventional wideband robust Capon beamforming, to wideband multipath rejection for shallow water SAS imaging. Numerical simulations of the proposed SAS processing have verified the performance improvements on output image quality over conventional processing in terms of both ghost target strength reduction and contrast enhancement. [J1064]

"The probabilistic data association filter"

The measurement selection for updating the state estimate of a target's track, known as data association, is essential for good performance in the presence of spurious measurements or clutter. A classification of tracking and data association approaches has been presented, as a pure MMSE approach, which amounts to a soft decision, and single best-hypothesis approach, which amounts to a hard decision. It has been shown that the optimal state estimator in the presence of data association uncertainty consists of the computation of the conditional pdf of the state x(k) given all information available at time k, namely, the prior information about the initial state, the intervening known inputs, and the sets of measurements through time k. It has also been pointed out that if the exact conditional pdf, which is a mixture, is available, then its recursion requires only the probabilities of the most recent association events. The conditions under which this result holds, namely whiteness of the noise, detection, and clutter processes, were presented. The PDAF and JPDAF algorithms, which carry out data association and state estimation in clutter, have been described. A simple example was given to illustrate how the clutter and occasional missed detections can lead to track loss for a standard tracking filter, and how PDAF can keep the target in track under such circumstances. By using the Monte Carlo in a simulated based surveillance as an exampled shown. The numerous applications of the PDAF/JPDAF illustrated in "Real-World Applications of PDAF and JPDAF" show the potential pitfalls of using sophisticated algorithms for tracking in difficult environments as well as how to overcome them. The effect of finite sensor resolution can be a more severe problem than the data association and deserves special attention. [J1065]

"Institutional Listings"

{no data available} [J1066]

"Report on First International Summer School on Radar/SAR"

In the picturesque Rhine Valley close to Bonn, more than 30 young students and scientists from all corners of the world congregated from July 24 to 31, 2009, to participate in the 1st International Summer School on Radar/SAR. The summer school was the initiative of Prof. Dr. Joachim Ender, director of one of Europe's foremost radar research establishments: the Fraunhofer Institute for High Frequency Physics and Radar (formerly, FGAN-FHR). Fraunhofer-FHR, in cooperation with renowned experts from across Europe and Canada, combined their creativity and scientific prowess to put together a program that would appeal to young scientists (particularly PhD candidates) across the globe. [J1067]

"A Dual-Polarized Planar-Array Antenna for S-Band and X-Band Airborne Applications"

A new dual-frequency dual-polarized array antenna for airborne applications is presented in this paper. Two planar arrays with thin substrates (R/T Duroid 5880 substrate, with epsivr= 2.2 and a thickness of 0.13 mm) are integrated to provide simultaneous operation at S band (3 GHz) and X band (10 GHz). Each 3 GHz antenna element is a large rectangular ring-resonator antenna, and has a 9.5 dBi gain that is about 3 dB higher than the gain of an ordinary ring antenna. The 10 GHz antenna elements are circular patches. They are combined to form the array with a gain of 18.3 dBi, using a series-fed structure to save the space of the feeding line network. The ultra-thin array can be easily placed on an aircraft's fuselage, due to its lightweight and conformal structure. It will be useful for wireless communication, radar, remote sensing, and surveillance applications. [J1068]

"Signal-to-noise ratio threshold effect in track before detect"

Track before detect (TBD) refers to simultaneous detection and tracking using unthresholded sensor responses over time. The motivation for TBD is its capacity to deal with low signal-to-noise ratio (SNR) targets. Previously, the achievable error for TBD has been established using Crameacuteracute-Rao analysis. Although computationally simple the Crameacuteracute-Rao bound is not useful at low SNR as it does not predict the threshold effect. A more accurate notion of the achievable performance at low SNRs is provided by the computationally more complicated Barankin bound. The computational complexity of the Barankin bound arises from the need to optimise over a number of test points, with the tightness of bound increasing with the number of test points. An approximation to the Barankin bound is proposed which permits the use of multiple test points with reasonable computational expense. The improvements in threshold SNR prediction offered by the proposed bound are demonstrated in numerical examples. [J1069]

"Verification of Polarimetric Calibration Method Including Faraday Rotation Compensation Using PALSAR Data"

The spaceborne Phased Array L-band Synthetic Aperture Radar (PALSAR) needs polarimetric calibration in order for PALSAR data to be utilized for various applications such as geophysical analysis. In case of a PALSAR system using L-band, the Faraday rotation (FR) effect, which rotates the polarization plane of radio waves, becomes a problem when full-polarimetric observation data are used, such as target classification using polarization synthesis. Therefore, we need to estimate and remove both antenna distortion matrices and the FR effect. In this paper, we propose a polarimetric calibration method taking both channel imbalance and crosstalk of receiving and transmitting antennas and FR effect into consideration using two reference reflectors, namely, polarization preserving reflector and polarization rotating one. Then, we apply our calibration method to PALSAR data and derive antenna distortion matrices and FR angle simultaneously. Our calibration results show that the estimated antenna distortion matrices are almost equal to the calibration results from the Japan Aerospace Exploration Agency and that the estimated FR angle has a reasonable value. [J1070]

"New Classes of Optimal Frequency-Hopping Sequences by Interleaving Techniques"

In this paper we construct new classes of optimal frequency-hopping sequences (FHSs) with respect to the Lempel-Greenberger bound and the Peng-Fan bound by interleaving techniques which are used to construct a sequence of length kN from k sequences of length N. We first give two generic constructions for optimal FHS sets from some known optimal FHS sets by interleaving techniques and present some examples of new optimal FHS sets. We then design new optimal FHSs whose parameters include those of the known optimal constructions with length kN and frequency set size n for some positive integers k and N. We also construct optimal FHS sets of length kp from power-residue sequences for any odd prime p and 2 les k < p. In particular, our constructions give several new parameters not covered in the literature, which are summarized in I and II. [J1071]

"On the Utility of Laguerre Series for the Envelope PDF in Multipath Fading Channels"

It is well known that multipath fading significantly affects the performance of communication systems. In order to incorporate the impact of this random phenomenon on system analysis and design, in many cases, we need to calculate the probability density function (pdf) of the received signal envelope in multipath fading channels. In this paper, we consider a general multipath fading channel with arbitrary number of paths, where the amplitudes of multipath components are arbitrary correlated positive random variables, independent of phases, whereas the phases are independent and identically distributed random variables with uniform distributions. Since the integral form of the envelope pdf for such a general channel model is too complicated to be used for analytic calculations, we propose two infinite expansions for the pdf: a Laguerre series and a power series. Based on the tight uniform upper bounds on the truncation error of these two infinite series, we show that the Laguerre series is superior to the power series due to the fact that for a fixed number of terms, it yields a smaller truncation

error. This Laguerre series with a finite number of terms, which expresses the envelope pdf just in terms of simple polynomial-exponential kernels, is particularly useful for mathematical performance prediction of communication systems in those indoor and outdoor multipath propagation environments, where the number of strong multipath components is small. [J1072]

"Polarimetric PALSAR Calibration"

Polarimetric Phased-Array-type L-band Synthetic Aperture Radar (PALSAR) system parameters are assessed using data sets collected over several calibration sites. The data collected over the Amazonian rain forest help validate the hypothesis that Faraday rotation is zero near the equator. The analysis of the Amazonian forest data and the response of the corner reflectors deployed there during the PALSAR acquisitions lead to the conclusion that the antenna is highly isolated (better than -35 dB). These results are confirmed using the data collected over calibration sites located in Sweden and Canada. The 5-m-height corner reflector deployed at the Remningstorp (Sweden) calibration site by Chalmers University of Technology provides accurate measurement of antenna parameters and detection of a (2deg -3deg) Faraday rotation during day-time acquisitions, whereas no Faraday rotation was noted during night-time acquisitions. Small Faraday rotation angles (2deg-3deg) have been measured using acquisitions over the DLR Oberpfaffenhofen and the Ottawa calibration sites. The presence of small but still significant Faraday rotation (2deg-3deg) induces a corner reflector return at the cross-polarization HV and VH that should not be interpreted as the actual antenna crosstalk. These results show that the PALSAR antenna is highly isolated (better than -35 dB), and diagonal antenna distortion matrices (with zero crosstalk terms) can be used for accurate calibration of PALSAR polarimetric data. [J1073]

"Radar target classification method with reduced aspect dependency and improved noise performance using multiple signal classification algorithm"

This study introduces a novel aspect and polarisation invariant radar target classification method based on the use of multiple signal classification (MUSIC) algorithm for feature extraction. In the suggested method, for each candidate target at each designated reference aspect, feature matrices called `MUSIC spectrum matrices (MSMs)` are constructed using the target`s scattered data at different late-time intervals. An individual MSM corresponds to a map of a target`s natural resonance-related power distribution over the complex frequency plane under the chosen aspect angle`late-time interval conditions. The collection of these feature matrices is used first to determine the best late-time interval for optimal feature extraction. Then, the MSM of a target, which are computed over the optimal time interval at all reference aspects, are superposed to obtain the `fused MUSIC spectrum matrix (FMSM)`. The FMSM of a target is its main classifier feature in the proposed method as the aspect dependency of an FMSM is highly reduced because of its multi-aspect construction process. The suggested method is demonstrated for both simple and complex target geometries such as conducting spheres, dielectric spheres and small-scale aircraft targets with high accuracy rates even for low SNR values using feature fusion at only a few different reference aspects. [J1074]

"Models and performance evaluation for multiple-input multiple-output space-time adaptive processing radar"

Signal and clutter modelling and optimum performance evaluation for multiple-input multiple-output (MIMO)-based space-time adaptive processing radar is addressed. A signal model is developed to account for both code diverse MIMO (c-MIMO) and frequency diverse MIMO (f-MIMO), and a general framework on performance evaluation is presented to take into account various waveform configurations including phased array (PA), partially correlated MIMO and ideally orthogonal MIMO. The proposed framework evaluates the system performance through optimum processing (OP) gain and transmit array (TA) gain. The OP gain is in turn evaluated by the number of available space-time measurements (ASMs) that depends on the number of clutter degrees of freedom (clutter NDoF) relative to the system degrees of freedom (system NDoF). The waveform diversity introduced by MIMO, especially f-MIMO, could significantly enhance the OP gain by increasing the number of ASMs. Hence, in OP-gain-limited scenarios, where the overall performance significantly degrades despite the TA gains, the preferable configuration in terms of optimum performance would be ordered as f-MIMO, c-MIMO, and last, PA, that is, no MIMO. [J1075]

"Foreword to the Special Issue on Calibration and Validation of ALOS Sensors (PALSAR, AVNIR-2, and PRISM) and Their Use for Bio- and Geophysical Parameter Retrievals"

The 17 papers in this special issue focus on the calibration and validation of ALOS sensors and their use for bio- and geophysical parameter retrievals. [J1076]

"Adaptive CA-CFAR threshold for non-coherent IR-UWB energy detector receivers"

In the present letter, a new adaptive threshold comparison approach for time-of-arrival (TOA) estimation in ultra wideband (UWB) signals is proposed. This approach can be used with non-coherent energy detector receivers in UWB systems. It exploits the idea of cell averaging constant false alarm rate (CA-CFAR) used in radar systems, where the threshold changes every energy block. The performance of several approaches are compared via Monte Carlo simulations using the CM1 channel model of the standard IEEE 802.15.4a. Both simulation results and comparisons are provided highlighting the effectiveness of the proposed approach. [J1077]

"Improving the noise performance of communication systems: radio and telephony developments of the 1920s [JHistory of Communications]"

This article discusses the early pioneering work of both telephone and radio engineers in effecting improvements in the noise performance of communication systems. This work led ultimately to the explosive growth of communication activities following World War II. Radio engineers during the 1920s were most concerned with reducing the impact of externally generated "static," and showed this could be accomplished by the use of directional antennas and moving to higher-frequency transmission. Telephone engineers during that period of time, most prominently John R. Carson of AT&T, were led to include the impact of "fluctuation noise" (shot and thermal noise) as well. Carson, using the then novel concept of noise frequency spectrum, showed how the appropriate choice of bandwidth and frequency of transmission could be used to improve the signal-to-noise ratio, anticipating the concept of a "matched filter" introduced 20 years later during radar developments of World War II. This early work on improving the noise performance of communication systems led, in the early 1930s, to Edwin H. Armstrong's spectacular leap ahead with his invention of wide-deviation low-noise frequency modulation (FM), followed a few years later by the invention by Alec Reeves of pulse code modulation (PCM), the first low-noise digital communication system of the modern era. [J1078]

"Phased array technology in Australia"

Australia has been developing and fielding phased array appUcations since the early 1950s. The application areas range from radio astronomy and atmospheric sciences, through over-the-horizon radar (OTHR), surface wave, microwave ship, and airborne systems. Given Australia's unique geographical size, position, single continent, and national identity, it is not surprising that much of this effort has focused on long range over-the-horizon technology both for environmental observation and surveillance of the extensive land and maritime regions of national interest and responsibility. This discussion will draw focus on just a few of the historical and current programs finishing with an overview of the current application of actiive phased array developments for ship defence. [J1079]

"Parallel MoM Using Higher-Order Basis Functions and PLAPACK In-Core and Out-of-Core Solvers for Challenging EM Simulations"

Typically, the problem size that can be solved by the Method of Moments (MoM) is limited by the amount of RAM installed in the computer. To reduce the number of unknowns for MoM, higher-order polynomial functions have been introduced as the basis functions. To extend the capability of the MoM code, this paper presents a new development: the use of a new parallel out-of-core solver called PLAPACK. The PLAPACK library package offers benefits that are not available in the more commonly used ScaLAPACK libraries. Numerical results on a typical computer platform for two different challenging electromagnetic problems show that the PLAPACK out-of-core solver introduced here is a very efficient way to deal with large matrix equations. The implementation of these advancements creates a powerful tool for the efficient computational electromagnetic solution of large and complex real-world problems. [J1080]

"Institutional Listings"

{no data available} [J1081]

"IEEE-USA-Supported Local TV News Reports [JIEEE-USA]"

{no data available} [J1082]

"High Scalability FMM-FFT Electromagnetic Solver for Supercomputer Systems"

An efficient parallel implementation of the Fast Multipole Method (FMM) combined with the fast Fourier transform (FFT) is presented in this paper. The good scaling properties of the FMM-FFT, combined with a smart parallelization strategy, has been shown to be very effective when using large parallel supercomputers. A challenging problem with more than 150 million unknowns has been solved, demonstrating that the proposed

implementation of the FMM-FFT constitutes a real alternative to the more frequently used multilevel approaches, such as the Multilevel FMM (MLFMA). Even more importantly, we have achieved a high efficiency with 1,024 parallel processors, which indeed constitutes one of the better scalability results ever reached for a rigorous integral-equation electromagnetic solver. [J1083]

"Ambient vibration testing of bridges by microwave interferometer"

Recent progress in radar techniques and systems led to the development of an interferometric radar suitable to the application in dynamic testing and vibration monitoring of civil engineering structures. The main characteristic of the new radar system is the possibility of simultaneously measuring the (static or dynamic) displacement of several points of a structure with high sensitivity. This describes the major characteristics of the microwave interferometer and its application to ambient vibration testing of full-scale bridges. [J1084]

"Where next for airborne AESA technology?"

Airborne radar has evolved from early systems where almost all radar characteristics were fixed to today's highly flexible, software-driven systems. The most recent advance has been the widespread adoption of active electronically scanned array (AESA) antennas, which has given the system designer unprecendented control of antenna characteristics. However, in common with most conventional radars, even these systems only operate within a limited frequency band. This argues that the next major advance will be the advent of wideband and multi-band systems, thus addressing the major remaining constraint facing the system designer and offering the capability for a step change in the functionality and performance of future systems. [J1085]

"The German satellite mission TerraSAR-X"

TerraSAR-X is Germany's first national remote sensing satellite being implemented in a public-private partnership between the German Aerospace Centre (DLR) and EATS Astrium GmbH. TerraSAR-X was launched on June 15, 2007 and will supply high-quality radar data for purposes of scientific observation of the Earth for a period of at least five years. At the same time, it is designed to satisfy the steadily growing demand of the private sector for remote sensing data in the commercial market. [J1086]

"Design of X-band complementary metal-oxide semiconductor-based frequency-modulation continuous-wave sensor"

This study presents an X-band complementary metal-oxide semiconductor-based frequency-modulation continuous-wave (FMCW) sensor system for transportation management. The proposed sensor system has two antennas, one to transmit signals and the other to receive them. The complete radio frequency (RF) transceiver is based on standard 0.18 m one-poly six-metal (1P6M) CMOS technology with a chip area of 1.68 mm 1.6 mm. Two planar leaky-mode antenna arrays with a gain of 18 dB are also designed. Experimental results indicate that the isolation between two antenna arrays that are 5.0 mm apart exceeds 42.0 dB at 10.5 GHz. The prototype of the FMCW sensor system is used in the range measurement of multiple lanes for the transportation management system (TMS). The major contribution of this study is that it integrates a 0.18 m CMOS transceiver and antenna arrays into an FMCW RF front end, and employs an IF amplifier and a digital signal processor to demonstrate that the beat frequencies are linear. Measurements made in field tests agree closely with the simulation results. [J1087]

"Potential technological breakthroughs for phased array antennas"

This reports on the analysis of technologies opening avenues for potential technological breakthroughs in phased array antennas. We report on recent results on the insertion of hardware technologies such as RF MEMS and RF photonics, in the front-end of phased array antennas. Future prospects for the insertion of nanotechnologies are presented. [J1088]

"Nanotechnology radar thermal management"

Active phased array antennas in state-of-the-art radars, adopt many high power amplifiers. High power transmit-receive modules are assembled in dense electronic environments and have to cope with severe environmental operative condition. Radar state-of-the-art systemic signal processing requires growing and enormous power calculation in order to obtain unprecedented hard real-time performances as well as implementing adaptive knowledge-based algorithms. Unfortunately, the present steady growth of the micro-processors performance are reaching a saturation point due to the approaching limit of miniaturizations. Present and future active phased array antennas and signal processors have large and increasing heat dissipation problems. Nanotechnologies are emerging as enabling technologies that will provide a revolution in the sectors of sensors and radar systems.

These innovative technologies could enable new solutions and improve weight, size, speed, power consumption, efficiency, and so on. In addition, the nanotechnologies could solve the increasing heat dissipation problems by adopting Carbon NanoTubes CNT ropes or arrays for thermal management and interconnection. [J1089]

"From radar to nodar"

Photonics and nanotechnologies are emerging revolutionary technologies that will provide a revolution in the sectors of sensors and radar systems. SELEX Sistemi Integrati intends to face this evolution as a leader by pro-actively supporting and developing its state-of-the-art. One century after the first RADAR Г‚ВїideaГ‚Вї we registered the Nanotechnology Optical Detection And Ranging (NODAR) trademark. Such NODAR, by including both photonic and nanotechnologies, aims to implement multi-functional, multi-role, multi-domain sensors, as well as adaptive, flexible, knowledge-based sensors. NODAR requires pro-active studies and developments on: nanotechnology vacuum tube amplifiers (TX reverse nano triode): wide bandwidth Tx-Rx optical beam-forming network by means of optical modulator, combiner, analogue optical receive and programmable true time delay; broadband photonic analogue to digital converters; thermal management and interconnection by means of carbon nanotubes; and nanotechnology infrared and chemical state-of-the-art sensors. [J1090]

"Arctic sea ice mapping with satellite radars"

The drastic reduction of Arctic sea ice in recent years demands ice monitoring over various spatial and temporal scales. Sea ice backscatter signatures from field measurements and from model analyses are obtained at L-band and C-band frequencies. Based on these signatures, capabilities for Arctic sea ice mapping are determined for current and future satellite active microwave sensors including synthetic aperture radars (SAR) and scatterometers. This study includes L-band and C-band radars such as the ERS (European Remote Sensing), Envisat (Environmental Satellite), RADARSAT-1 and 2, ALOS (Advanced Land Observing Satellite), and DESDnyl (Deformation, Ecosystem Structure, and Dynamics of Ice). SARs with resolutions from 10 to 100 m, and the SMAP (Soil Moisture Active-Passive) scatterometer with resolutions from 1 to 10 km. [J1091]

"Comparison of Output SINR and Receiver C/N_0 for GNSS Adaptive Antennas"

Antenna arrays with space-time adaptive processing (STAP) are commonly utilized to allow the reception of signals in harsh interference environments. The primary applications of STAP have been radar and communications systems, where the STAP weights are optimized for output signal-to-interference-plus-noise ratio (SINR); however, there is increasing demand for STAP in time-of-arrival (TOA) estimation applications, such as global navigation satellite system (GNSS) receivers. It is understood that TOA estimation performance is primarily dependent on receiver postcorrelation carrier-to-noise ratio (C/N0). In this study, the distinction between SINR and C/N0is established, and a performance analysis of the common STAP algorithms is performed in the presence of interference. It is demonstrated that output SINR is an inadequate indication of GNSS receiver C/N0performance. As a result, caution should be used when measuring the relative performance of different STAP algorithms in GNSS applications. Consequently, the present work develops a novel STAP algorithm which maximizes C/N0. Additionally, the performance of common STAP algorithms is analyzed in the context of this performance bound, and it is demonstrated that, in many cases, their performance is near optimal. [J1092]

"Speaker selection and tracking in a cluttered environment with audio and visual information"

Presented in this paper is a data association method using audio and visual data which localizes targets in a cluttered environment and detects who is speaking to a robot. A particle filter is applied to efficiently select the optimal association between the target and the measurements. State variables are composed of target positions and speaking states. To update the speaking state, we first evaluate the incoming sound signal based on cross-correlation and then calculate a likelihood from the audio information. The visual measurement is used to find an optimal association between the target and the observed objects. The number of targets that the robot should interact with is updated from the existence probabilities and associations. Experimental data were collected beforehand and simulated on a computer to verify the performance of the proposed method applied to the speaker selection problem in a cluttered environment. The algorithm was also implemented in a robotic system to demonstrate reliable interactions between the robot and speaking targets. [J1093]

"Vladimir Aleksandrovich Kotelnikov: pioneer of the sampling theorem, cryptography, optimal detection, planetary mapping... [JHistory of Communications]"

In 1933 the young Russian communications engineer Vladimir Aleksandrovich Kotelnikov published a paper in which he formulated, for the first time in an engineering context, the sampling theorem for lowpass and bandpass signals. He also considered the bandwidth requirements of discrete signal transmission for telegraphy and images. Kotelnikov subsequently worked on scrambling, cryptography, optimal detection, and planetary radar

(including the radar-assisted cartography of Venus). He was awarded numerous Soviet and international prizes, and played a major role in Soviet academic and professional life in the field of radio engineering. Yet his achievements are still comparatively little known outside Russia. [J1094]

"The PALSAR Polarimetric Mode for Sea Oil Slick Observation"

A study on sea oil slick observation by means of L-band polarimetric synthetic aperture radar (SAR) data is accomplished. It is based on different sea surface scattering mechanism expected with and without surface slicks. Polarimetric measurements are processed by means of a simple and very effective filtering technique which is electromagnetically based on the Mueller scattering matrix. Moreover, some polarimetric features, evaluated on both slick-free and slick-covered sea surfaces, are analyzed for confirming the filter output. Experiments are accomplished on the polarimetric SAR data acquired by the Phased Array-type L-band Synthetic Aperture Radar (PALSAR) sensor, mounted on board of the Advanced Land Observing Satellite (ALOS), and are relevant to oil slick, due to a tank accident, and look-alikes. Results demonstrate for the first time that L-band polarimetric SAR measurements are useful for oil slick observation purposes and witness the capability of the ALOS PALSAR data for such application. [J1095]

"Microwave Subsurface Imaging Using Direct Finite-Difference Frequency-Domain-Based Inversion"

We have developed a new algorithm for electromagnetic inverse scattering problems in inhomogeneous media using finite-difference frequency-domain (FDFD) forward modeling, referred to as the FDFD-based inversion method. The key issue of this method is to build a linear expression for the inverse problem from an FDFD forward model by using Born approximation to neglect mutual coupling between scattered pixels and to then solve for the inverse coefficient matrix. An important advantage of this matrix-based method is that there is no need to specify a Green's function. As such, this inverse scattering algorithm is easily implemented and is robust to the heterogeneity in the background. We test the algorithm with a microwave subsurface object detection application using cross-well radar. The new method is compared with conventional inversion using Green's function-based Born approximation. Numerical experiments are presented for a 2-D borehole geometry for buried object detection in uniform soil and in multilayered soil backgrounds. [J1096]

"A Brief History of Radar"

In his report about experiments with radio communication in the Baltic Sea in 1897, Russian scientist Alexander Popov reported the detection of a warship "Lieutenant Il'in" when it crossed the radio communication link between two other ships "Europe" and "Africa". This observation was the first mention about the possibility of object detection by means of radio waves. The first patent on the phenomena was obtained in 1904 by German engineer Christian Hiilsmeyer who called this device the "Telemobiloskop". However, neither A. Popov's observation nor C. Hulsmeyer's invention was the subject of any development up to the 1930s of the 20th century. This is a partial summary of the work done by the Soviet Union and Russia in the field of radar. [J1097]

"Estimation of Soil Moisture and Faraday Rotation From Bare Surfaces Using Compact Polarimetry"

The potential of compact polarimetry (CP) mode at longer wavelengths in a space environment for surface parameter estimation is investigated. CP consists of transmitting a single polarization while receiving two polarizations. At longer wavelengths, one of the main challenges associated with CP from space is Faraday rotation (FR) estimation and correction. In this paper, an estimation procedure for FR is presented, which relies on the scattering properties of bare surfaces. The selection of the bare surfaces is based on a new parameter, the conformity coefficient computed from CP measurements. This parameter is shown to be FR invariant. Once estimated, the FR can be corrected over the whole image. A simple approximation to sigmaHHoand sigmaVVobased on CP measurements over bare soil surfaces is presented, from which soil moisture can be estimated using the 1995 Dubois algorithm. The results obtained using CP are shown to be in good agreement with those obtained from the standard Dubois algorithm using fully polarimetric data. This implies that, for soil moisture, CP can be used instead of HH and VV dual-polarized measurements. [J1098]

"Phased Array Radar Polarimetry for Weather Sensing: A Theoretical Formulation for Bias Corrections"

It is becoming widely accepted that radar polarimetry provides accurate and informative weather measurements, while phased-array technology can shorten data updating time. In this paper, a theory of phased array radar (PAR) polarimetry is developed to establish the relation between electric fields at the antenna of the PAR and

the fields in a resolution volume filled with hydrometeors. It is shown that polarimetric measurements with an electronically steered beam can cause measurement biases that are comparable to or even larger than the intrinsic polarimetric characteristics of hydrometeors. However, these biases are correctable if the transmitted electric fields are known. A correction to the measured scattering matrix that removes biases in meteorological variables is derived. The challenges and opportunities for weather sensing with a polarimetric PAR are discussed. [J1099]

"A New Method for Correcting ScanSAR Scalloping Using Forests and Inter-SCAN Banding Employing Dynamic Filtering"

The Scanning Synthetic Aperture Radar (ScanSAR) is very useful for Earth observation because of its wider imaging swath and shorter revisit time. However, ScanSAR is sometimes affected by the following three artifacts: (1) scalloping, which often appears as repeating weak azimuth stripes at both edges of the focused burst image; (2) azimuth ambiguity (i.e., a form of ghosting that appears over the adjacent uniform area when the pulse repetition frequency is below the Doppler bandwidth); and (3) radiometric discontinuity (i.e., banding) between two adjacent scans. This paper proposes three methods to correct these artifacts, which are, specifically, the proposal for scalloping correction using Amazon Rainforest data, band limitation, and the correction for the inter SCAN banding using the dynamic gain correction algorithm. Several corrected sample data sets of the Phased-Array L-band SAR onboard the Advanced Land-Observing Satellite are presented to demonstrate the validity of the proposed methods. [J1100]

"Pitch estimation for non-cooperative maritime targets in ISAR scenarios"

Maritime targets are usually involved in complex motions that complicate the generation of focused inverse synthetic aperture radar (ISAR) images and their scaling in cross-range. By assuming some hypotheses that translate to some restrictions in the maritime surveillance scenario, a signal model for the phase history is derived. This function is calculated here using phase gradient autofocus and can be related to the pitch motion of the ship, which may consequently be estimated. The amplitude and the period of this pitch estimate allow us to select imaging times at which the ISAR images are descriptive for classification purposes. The cross-range scaling of these images is also achieved. Simulated data are used to validate the technique and to evaluate its performance when deviations from the nominal scenario are present. Results obtained with live data acquired by a high-resolution radar confirm the effectiveness of the approach. [J1101]

"Eliminating ghost images in high-range resolution profiles for stepped-frequency train of linear frequency modulation pulses"

In modern radar systems, using stepped-frequency pulse train is an effective approach to achieve high-range resolution (HRR) with narrow instantaneous bandwidth and low system complexity. However, if the parameters of stepped-frequency (SF) radar (such as single pulse bandwidth, frequency step size and sampling instant) are not prudently designed, `ghost image` phenomenon (also called range ambiguity in some literature) will corrupt the synthetic HRR profiles. The relationship between parameters of the SF radar and the ghost images is provided analytically. A new synthetic range profiling algorithm is developed to generate HRR profiles without ghost images by using the least-squares (LS) estimation. For targets with negligible radial velocities, the new LS profiling algorithm can eliminate the ghost images successfully, and introduces less signal-to-noise ratio loss. With this algorithm, the restriction on the frequency step size is less rigid than the traditional unambiguous criterion. Consequently, a higher range resolution could be obtained. Simulations and field experimental results are also presented. [J1102]

"Bistatic clutter analysis and range ambiguity resolving for space time adaptive processing"

The clutter characteristics of bistatic airborne radar are more complex than those of monostatic airborne radar. The clutter spectra not only vary severely with range, but also vary with bistatic configuration. The problem of range dependence is more serious in monostatic airborne radar. In this paper, the geometry of arbitrary bistatic airborne radar configuration is firstly analysed, and a formula for Doppler frequency calculation with the variables of azimuth angle and bistatic range is deduced, which is an efficient tool for bistatic clutter analysis. Because of the severe clutter range dependence, the processing of compensation is indispensable in space time adaptive processing (STAP). However, when range ambiguity occurs, the compensation is difficult to be applied to each clutter range cell. To solve this problem, a range ambiguity resolving approach is further proposed by utilising azimuth elements in phased array. Because this approach will result in spatial degrees of freedom (DOF) loss, the overlapped subarray processing is introduced in order obtain enough spatial DOF for STAP. By doing so, the compensation for mitigating range dependence can be applied effectively to bistatic clutter. [J1103]

"Direction-of-arrival estimation in radar systems: moving window against approximate maximum likelihood estimator"

In this study, we compare two radar target direction-of-arrival (DOA) estimation algorithms: the classical moving window (MW) estimator, implemented in many real radar systems and the approximate maximum likelihood (AML) estimator. The first technique exploits multiple detections in the same time-on-target and the second one exploits the fact that the radar antenna mechanical scanning impresses an amplitude modulation on the signals backscattered by the target. Performances of the two estimators are numerically investigated through Monte Carlo simulation and compared in terms of root-mean-square-error (RMSE), probability of detection and probability of target splitting, the latter being defined as the probability of detecting more than one target when instead only one is present in the cell under test. Numerical results show that the AML estimator generally outperforms the classical MW estimator, also in terms of robustness to target splitting. [J1104]

"Improved autofocusing of stepped-frequency ISAR images using new form of particle swarm optimisation"

An autofocusing method is proposed to compensate for the inter-pulse phase errors in stepped-frequency ISAR imaging. A genetic algorithm, particle swarm optimisation (PSO), and a combination of PSOs (CPSO) model were applied and compared with the existing subarray averaging and entropy minimisation method. In simulations using measured data, CPSO gave the most accurate and stable results. [J1105]

"Adaptive radar phase-coded waveform design"

A simple and successful design for an adaptive radar phase-coded waveform is presented. The optimised phase-coded waveform is designed by the phase-only conjugate gradient method. The signal-to-interference-plus-noise ratio of the optimised phase-coded waveform is compared with an optimal waveform and good approximation is achieved. [J1106]

"Identifiability and Aliasing in Polynomial-Phase Signals"

Polynomial-phase signals have numerous applications including radar, sonar, geophysics, and radio communication. Many techniques for estimating the parameters of polynomial-phase signals have been described in the literature. Despite the significant interest, aliasing of polynomial-phase parameters has not been fully clarified. We address the problem of identifiability and aliasing in polynomial-phase signals. We fully describe the region in which aliasing does not occur for polynomial-phase signals of any order. We call this the identifiable region. We find that this region is the Voronoi region of a lattice generated by the coefficients of a set of polynomials known as the integer-valued polynomials. We show how aliasing can be resolved by solving the nearest lattice point problem. We discuss some of the consequences of these results on a popular estimator for polynomial-phase signals that is based on the discrete polynomial phase transform (DPPT). It is shown that the range of parameters suitable for the DPPT estimator is very small compared to the identifiable region. [J1107]

"Modeling and performance analysis of SAW reader systems for delay-line sensors"

In this contribution, we present a comprehensive modeling approach for delay line-based surface acoustic wave (SAW) sensor reader systems, which provides valuable insight into the interaction of the individual system parameters. A parametric analysis of signal strength, noise, and quantization effects and consideration of important signal processing parameters, such as data windows and averaging, allows prediction of the achievable statistical measurement accuracy by closed-form solutions. The performance and capabilities of the derived model are verified on system design examples as well as multiple practical measurement scenarios, using a prototype 2.45-GHz frequency-stepped continuous-wave SAW reader system. [J1108]

"Vibration-induced PM and AM noise in microwave components"

The performance of microwave components is sensitive to vibrations to some extent. Aside from the resonator, microwave cables, and connectors, bandpass filters, mechanical phase shifters, and some nonlinear components are the most sensitive. The local oscillator is one of the prime performance-limiting components in microwave systems ranging from simple RF receivers to advanced radars. The increasing present and future demand for low acceleration sensitive oscillators, approaching 10-13/g, requires a reexamination of sensitivities of basic nonoscillatory building-block components under vibration. The purpose of this paper is to study the phase-modulation (PM) noise performance of an assortment of oscillatory and nonoscillatory microwave components under vibration at 10 GHz. We point out some challenges and provide suggestions for the accurate measurement of vibration sensitivity of these components. We also study the effect of vibration on the amplitude-

modulation (AM) noise. [J1109]

"Collision Sensing by Stereo Vision and Radar Sensor Fusion"

To take advantage of both stereo cameras and radar, this paper proposes a fusion approach to accurately estimate the location, size, pose, and motion information of a threat vehicle with respect to a host one from observations that are obtained by both sensors. To do that, we first fit the contour of a threat vehicle from stereo depth information and find the closest point on the contour from the vision sensor. Then, the fused closest point is obtained by fusing radar observations and the vision closest point. Next, by translating the fitted contour to the fused closest point, the fused contour is obtained. Finally, the fused contour is tracked by using rigid body constraints to estimate the location, size, pose, and motion of the threat vehicle. Experimental results from both synthetic data and real-world road test data demonstrate the success of the proposed algorithm. [J1110]

"Employing a Method on SAR and Optical Images for Forest Biomass Estimation"

In this paper, we develop a novel method for forest biomass estimation. The intensity values of Advanced Land Observation Satellite-Advanced Visible and Near Infrared Radiometer type 2 and PRISM images and the texture features of the Japanese Earth Resources Satellite 1 image are used in a multilayer perceptron neural network (MLPNN) that relates them to the forest variable measurements on the ground. A proposed speckle noise model is also applied for modeling and reducing the speckle noise in the synthetic aperture radar (SAR) image. Reducing the speckle would improve the discrimination among different land use types and would make the textual classifiers more efficient in SAR images. Ideally, filters will reduce the speckle without loss of information. In the process of the forest biomass estimation, the filters should preserve the backscattering coefficient values and edges between different areas. We investigate both quantitative and qualitative criteria in speckle reduction and texture preservation to evaluate the performance of the proposed filter in the forest biomass estimation. We will also show that the biomass estimation accuracy is significantly improved in an MLPNN when the radar and the optical data are used in combination compared to estimating the biomass by using a single datum only. The root-mean-square error (rmse) value is decreased when the proposed method is used (rmse= 2.175 ton) compared with that of the classic method (rmse= 5.34 ton). [J1111]

"Impact of Noncoherent Pulse Integration on RCS-Assisted Tracking"

Single-frame measurement-to-track association algorithms that make unique decisions often have difficulty with closely-spaced (but resolved) targets. Such algorithms typically operate on a kinematic measurement-to-track cost matrix. When targets under track are closely spaced in kinematic measurement space, the corresponding elements of this matrix are similar. Given little information upon which to base decisions, it is not surprising that mistakes are made. One approach proposed in the literature for mitigating this problem is to augment the kinematic measurement-to-track costs with signal amplitude information. However, prior work demonstrates that this can actually be detrimental to the measurement-to-track association process for radar tracking. The potential benefits of noncoherent pulse integration on amplitude-assisted tracking is investigated here. It demonstrates that when targets are closely spaced, integrating pulses essentially separate the amplitude distributions, making amplitude-assisted tracking more effective. Guidance for determining when to apply amplitude-assisted tracking is also provided. [J1112]

"HRR Automatic Target Recognition from Superresolution Scattering Center Features"

The work presented here introduces a procedure for the automatic recognition of ground-based targets from high range resolution (HRR) profile sequences that may be obtained from a synthetic aperture radar (SAR) platform. The procedure incorporates an adaptive target mask and uses a superresolution algorithm to identify the cross-range positions of target scattering centers. These are used to generate a pseudoimage of the target whose low-order discrete cosine transform coefficients form the recognizer feature vector. Within the recognizer, the states of a hidden Markov model (HMM) are used to represent the target orientation and a Gaussian mixture model is used for the feature vector distribution. In a closed-set identification experiment, the misclassification rate for ten MSTAR targets was 2.8%. Also presented are results from open-set experiments and investigates the effect on recognizer performance of variations in feature vector dimension, azimuth aperture, and target variants. [J1113]

"A New Gaussian Mixture Algorithm for GMTI Tracking Under a Minimum Detectable Velocity Constraint"

This paper introduces a new methodology to account for Doppler blind zone constraints, arising, for example, in ground moving target indicator (GMTI) tracking applications. In such problems, target measurements are suppressed when the range rate (Doppler) of the target drops below a specified threshold in magnitude (the

minimum detectable velocity). The proposed method, employing Gaussian mixture approximations to the filtering density, differs from earlier Gaussian mixture approaches in the way missed measurements are modelled. The distinctive feature of the algorithm, as compared with other Gaussian mixture filters, is that it is based on an exact calculation of the filtering density when a measurement is not recorded. Algorithms that result from applying this methodology are simple to implement and computationally undemanding. Simulation results indicate a uniform improvement in estimation accuracy over that of earlier proposed analytic techniques, and a tracking performance comparable to that of state-of-the-art particle filters. [J1114]

"Frequency Bandwidth Narrowing Technology for Pulsed Magnetrons"

Technological developments in the design of unmodulated pulsed magnetrons have resulted in a dramatic improvement in the reduction of unwanted emission levels produced by these devices. This achievement is necessary to meet the increasing world demand of more efficient use of the radio frequency spectrum, which is seen today as a limited resource. Recently developed improved magnetrons utilize new techniques to reduce the unwanted emissions while also improving the spectrum in the utilized frequency bandwidth. This paper provides a detailed explanation of the processes and methodology used to achieve the reduction in unwanted emission levels for these unmodulated pulsed magnetrons. Additionally, we explain the theory of operation and the achieved results. The improved technology has already been utilized successfully on a commercial level worldwide over the last few years in radar systems operating in the S- and X-bands at power levels from 2 to 60 kW. [J1115]

"Computation of RCS of targets modelled with trimmed NURBS surfaces"

A novel technique for the monostatic radar cross-section (RCS) computation of complex targets modelled with trimmed nonuniform rational B-spline (NURBS) surfaces is proposed using physical optics (PO). The stationary phase method (SPM) is demonstrated to be invalid in evaluation of the PO integral over trimmed surfaces. Thus a new method, which combines SPM with the Gordon method (namely SPM-Gordon) is presented as a substitute and good candidate. Examples show that excellent accuracy is obtained. [J1116]

"Dual-band fractal shape antenna design for RFID applications"

A compact printed dipole antenna is proposed for radio frequency identification (RFID) applications. It consists of a combination of two kinds of fractal shapes with the aim of reducing antenna size. To ensure conjugate matching with the essentially complex impedance of the electronic chip directly embedded into the radiator, a double T-match structure is used. The antenna has been designed and optimised to cover the bi-band for the passive RFID tag at 915 MHz and 2.4 GHz. Details of the proposed antenna design and measured results are presented and discussed. [J1117]

"Effective Modulation of Ni Silicide Schottky Barrier Height Using Chlorine Ion Implantation and Segregation"

Using a presilicide implantation approach, we demonstrate that the Schottky barrier height (SBH) of NiSi/n-Si(100) can be modulated by doping a Si substrate with a halogen species such as chlorine. Activation energy measurements indicate that an ultralow barrier of 0.08 eV for NiS/n-Si can be achieved when a high dose (~1 times 1015cm2) of chlorine is implanted prior to Ni silicidation. A secondary ion mass spectroscopy analysis on the presilicide Cl-implanted NiSi shows chlorine segregates at the interface with SBH tuning from 0.68 to 0.08 eV on n-Si and a corresponding increase in hole SBH on p-Si(100). The presilicide Cl-implanted NiSi film also demonstrates an enhanced thermal stability with a low sheet resistively of < 28 muOmega even up to 850degC. [J1118]

"Quasi-circulator for effective cancellation of transmitter leakage signals in monostatic six-port radar"

A quasi-circulator, composed of two branch-line couplers and an asymmetric power combiner, is proposed to effectively cancel the transmitter leakage signals in a monostatic six-port radar. The effective isolation is improved by 12.2 dB at 24 GHz. With the proposed quasi-circulator, the maximum detectable range of the six-port radar is improved by 167, compared with that of the six-port radar with a conventional branch-line coupler. [J1119]

"Polar format tomographic method for far-field RCS extraction"

A polar format tomographic method employed for far-field radar cross-section (RCS) extraction is presented. The image processing and far-field RCS extraction are both performed by the polar format tomographic method.

Numerical results demonstrate an improvement of the accuracy and robustness of the extracted far-field RCS in comparison to the method with tomographic Cartesian image processing. [J1120]

"Results of a Precrash Application Based on Laser Scanner and Short-Range Radars"

In this paper, we present a vehicle safety application based on data gathered by a laser scanner and two short-range radars that recognize unavoidable collisions with stationary objects before they take place to trigger restraint systems. Two different software modules that perform the processing of raw data and deliver a description of the vehicle's environment are compared. A comprehensive experimental evaluation based on relevant crash and noncrash scenarios is presented. [J1121]

"Satellite Retrievals of Arctic and Equatorial Rain and Snowfall Rates Using Millimeter Wavelengths"

A new global precipitation retrieval algorithm for the millimeter-wave Advanced Microwave Sounding Unit is presented that also retrieves Arctic precipitation rates over surface snow and ice. This algorithm improves upon its predecessor by excluding some surface-sensitive channels and by reducing the number of principal components (PCs) used to represent those that remain. The training sets were also modified to better represent cold regions. The algorithm still incorporates conversion of brightness temperatures to nadir, spatial filtering to better detect pixels scattering near 54 GHz, PC filtering of surface effects, and use of separate neural networks trained with the fifth-generation National Center for Atmospheric Research/Penn State Mesoscale Model (MM5) for land and sea, where warm and cold ocean are now treated differently. The validity of the snowfall detections is supported by nearly coincident CloudSat radar observations, and the physics of the model is largely validated by the reasonable agreement in annual precipitation obtained for 231 globally distributed rain gauges, including many at latitudes where snowfall dominates. Observed annual global precipitation statistics are also presented to permit comparisons with other algorithms and sensors. [J1122]

"An Inversion Method for Extraction of Wind Speed From High-Frequency Ground-Wave Radar Oceanic Backscatter"

A new approach to extracting sea surface wind speed from high-frequency radar Doppler spectra is presented. Based on certain appropriate approximations associated with the Doppler region close to the first-order (Bragg) peaks, the second-order radar cross section equation is differentiated. Once Doppler shifts due to ocean currents are removed from the data, an expression that relates the wind speed to the frequency position of the second-order peak is derived. The method is applied to simulated noisy data as well as to field data obtained from a Seasonde (a product of CODAR Oceans Sensors) in Breezy Point, NY. In the latter case, the retrieved wind speeds are then compared to ground truth data measured by an anemometer from a National Oceanic and Atmospheric Administration weather station located in the vicinity of the illuminated patch of ocean. Subject to certain constraints as detailed in the manuscript, the algorithm shows significant promise. [J1123]

"RKHS Bayes Discriminant: A Subspace Constrained Nonlinear Feature Projection for Signal Detection"

Given the knowledge of class probability densities, aprioriprobabilities, and relative risk levels, Bayes classifier provides the optimal minimum-risk decision rule. Specifically, focusing on the two-class (detection) scenario, under certain symmetry assumptions, matched filters provide optimal results for the detection problem. Noticing that the Bayes classifier is in fact a nonlinear projection of the feature vector to a single-dimensional statistic, in this paper, we develop a smooth nonlinear projection filter constrained to the estimated span of class conditional distributions as does the Bayes classifier. The nonlinear projection filter is designed in a reproducing kernel Hilbert space leading to an analytical solution both for the filter and the optimal threshold. The proposed approach is tested on typical detection problems, such as neural spike detection or automatic target detection in synthetic aperture radar (SAR) imagery. Results are compared with linear and kernel discriminant analysis, as well as classification algorithms such as support vector machine, AdaBoost and LogitBoost. [J1124]

"Scaling Up Wide-Area-Search-Munition Teams"

Wide area search munitions (WASMs) are a cross between an unmanned aerial vehicle (UAV) and a munition. The first of these high-concept munitions, the low-cost autonomous attack system, was a miniature, autonomous WASM capable of broad-area search, identification, and destruction of a range of mobile ground targets. The LoCAAS used a small turbojet engine capable of powering the vehicle for up to 30 minutes and laser radar (ladar) with automatic target recognition to identify potential targets. The original LoCAAS was a fire-and-forget munition designed to operate independently. It flew preprogrammed search patterns until it located a target or

ran out of fuel. [J1125]

"SAR Image Regularization With Fast Approximate Discrete Minimization"

Synthetic aperture radar (SAR) images, like other coherent imaging modalities, suffer from speckle noise. The presence of this noise makes the automatic interpretation of images a challenging task and noise reduction is often a prerequisite for successful use of classical image processing algorithms. Numerous approaches have been proposed to filter speckle noise. Markov random field (MRF) modelization provides a convenient way to express both data fidelity constraints and desirable properties of the filtered image. In this context, total variation minimization has been extensively used to constrain the oscillations in the regularized image while preserving its edges. Speckle noise follows heavy-tailed distributions, and the MRF formulation leads to a minimization problem involving nonconvex log-likelihood terms. Such a minimization can be performed efficiently by computing minimum cuts on weighted graphs. Due to memory constraints, exact minimization, although theoretically possible, is not achievable on large images required by remote sensing applications. The computational burden of the state-of-the-art algorithm for approximate minimization (namely the alpha -expansion) is too heavy specially when considering joint regularization of several images. We show that a satisfying solution can be reached, in few iterations, by performing a graph-cut-based combinatorial exploration of large trial moves. This algorithm is applied to joint regularization of the amplitude and interferometric phase in urban area SAR images. [J1126]

"Achieving Higher Resolution ISAR Imaging With Limited Pulses via Compressed Sampling"

Recent theory of compressed sampling (CS) suggests that exact recovery of an unknown sparse signal with overwhelming probability can be achieved from very limited number of samples. In this letter, we adapt this idea and present a framework of high-resolution inverse synthetic aperture radar imaging with limited measured data. During the framework, we mathematically convert the imaging into a problem of signal reconstruction with orthogonal basis; hence, a conceptive upper bound of the cross-range resolution is presented based on the CS theory. Real data results show that the CS imaging approach outperforms the conventional range-Doppler one in resolution. [J1127]

"Selecting Suitable Coherent Processing Time Window Lengths for Ground-Based ISAR Imaging of Cooperative Sea Vessels"

Inverse synthetic aperture radar (ISAR) imaging of sea vessels is a challenging task because their 3-D rotational motion over the coherent processing interval (CPI) often leads to blurred images. The selection of the duration of the CPI, also known as the coherent processing time window length (CPTWL), is critical because it should be short enough to limit the blurring caused by the 3-D rotational motion and long enough to ensure that the desired cross-range resolution is obtained. This paper proposes an algorithm, referred to as the motion-aided CPTWL selector (MACS) algorithm, which selects suitable CPTWLs for ISAR imaging of cooperative sea vessels. The suggested CPTWLs may be used to obtain motion-compensated ISAR images that have the desired medium cross-range resolution and limited blurring due to 3-D rotational motion. The proposed algorithm is applied to measured motion data of three different classes of sea vessels: a yacht, a fishing trawler, and a survey vessel. Results show that longer CPTWLs are needed for larger vessels in order to obtain ISAR images with the desired cross-range resolution. The effectiveness of the CPTWLs, suggested by the MACS algorithm, is shown using measured radar data. The suggested CPTWLs may also be used to select an effective initial CPTWL for Martorella/Berizzi's optimum imaging selection algorithm when it is applied to measured radar data of small vessels. Lastly, the proposed technique offers significant computational savings for radar cross section measurement applications where a few high-quality ISAR images are desired from long radar recordings. [J1128]

"Radar-Based Breast Cancer Detection Using a Hemispherical Antenna Array-Experimental Results"

In this contribution, an ultrawideband (UWB) microwave system for breast cancer detection is presented. The system is based on a novel hemispherical real-aperture antenna array, which is employed in a multi-static radar-based detection system. The array consists of 16 UWB aperture-coupled stacked-patch antennas located on a section of a hemisphere. The radar system is designed to be used with realistic three-dimensional (3D) breast phantoms, which have been developed, as well as with real breast cancer patients during initial clinical trials. Images are formed using two different beamforming algorithms and the performance of these algorithms is firstly compared through numerical simulation. Experimental results for the same beamforming techniques are then presented, demonstrating the successful detection of 4 and 6 mm diameter spherical tumors in the curved breast phantom. [J1129]

"Cross-Range Scaling for ISAR Based on Image Rotation Correlation"

For better understanding of the imaging result provided by inverse synthetic aperture radar (ISAR), it is more desirable to present it from the conventional range-Doppler domain to the homogeneous range-cross-range domain. To accomplish the process of cross-range scaling, the rotating velocity (RV) of the target should be estimated first. For a uniformly planar rotating object, a novel method based on a concept of rotation correlation is proposed to obtain the RV in this letter, and neither prominent scattering centers nor phase coefficient extraction is required. Furthermore, a three-step fast-Fourier-transform-based convolution interpolation scheme is proposed to realize the above correlation, which makes the proposed method more efficient for implementation. Finally, experimental results with both simulated and real ISAR data are provided to demonstrate the effectiveness of the proposed method for different targets. [J1130]

"Simple microwave sensor for remote detection of structural vibration"

A simple microwave sensor for the detection of the dynamic characteristics of large structure vibration is proposed. It consists of a continuous-wave radar capable of detecting the structure movement by measuring the phase of the back-reflected wave. The system performances have been demonstrated in a case study monitoring a pedestrian bridge. [J1131]

"Terrain: Slope Influence on QuikSCAT Backscatter"

Soil moisture (SM) is an important variable in determining streamflow, agricultural productivity, weather, and climate. An effective way to map SM over large areas on a regular basis is by using active microwave observations. This paper examines the influence of topography on radar backscatter measurements for a range of vegetation conditions and on the development of a normalization technique for the correction of topography-induced variability. Radar backscatter observations derived from the QuikSCAT sensor were analyzed to investigate the effect of sloping terrain over the North American Monsoon Experiment region that is characterized by heterogeneous surface conditions and complex topographic terrain. A digital elevation model, along with local incidence angle and slope, was used to investigate the backscatter dependence on topography variation for eight main vegetation classes. Pearson product-moment correlation (R) analysis showed strong backscatter dependence on the local incidence angle caused by changes in slope. The overall average reduction in variances after correction for August 2004 depended on vegetation type and ranged between -16% to -42% and -18% to -37% for horizontal and vertical polarizations, respectively. The corrected sigma-0 was also evaluated using insituSM observations obtained during the Soil Moisture Experiment 2004 field campaign. The computed percent change in Rbetween sigma-0 and SM demonstrated significant improvement after correction when using vertically observed sigma-0. The standard errors of estimate for these two vegetation classes were lowered by about 12% and 5%, respectively, after applying the proposed topographic normalization technique to the QuikSCAT observations. [J1132]

"Wavelet-Based SAR Image Despeckling and Information Extraction, Using Particle Filter"

This paper proposes a new-wavelet-based synthetic aperture radar (SAR) image despeckling algorithm using the sequential Monte Carlo method. A model-based Bayesian approach is proposed. This paper presents two methods for SAR image despeckling. The first method, called WGGPF, models a prior with Generalized Gaussian (GG) probability density function (pdf) and the second method, called WGMPF, models prior with a Generalized Gaussian Markov random field (GGMRF). The likelihood pdf is modeled using a Gaussian pdf. The GGMRF model is used because it enables texture parameter estimation. The prior is modeled using GG pdf, when texture parameters are not needed. A particle filter is used for drawing particles from the prior for different shape parameters of GG pdf. When the GGMRF prior is used, the particles are drawn from prior in order to estimate noise-free wavelet coefficients and for those coefficients the texture parameter is changed in order to obtain the best textural parameters. The texture parameters are changed for a predefined set of shape parameters of GGMRF. The particles with the highest weights represents the final noise-free estimate with corresponding textural parameters. The despeckling algorithms are compared with the state-of-the-art methods using synthetic and real SAR data. The experimental results show that the proposed despeckling algorithms efficiently remove noise and proposed methods are comparable with the state-of-the-art methods regarding objective measurements. The proposed WGMPF preserves textures of the real, high-resolution SAR images well. [J1133]

"Lake Level Variations Monitored With Satellite Altimetry Waveform Retracking"

Over lake shores, altimetric waveforms are generally contaminated by lands, rough lake surfaces, and lag effects of the altimeter's automatic gain control. To improve altimeter ranging accuracy and in turn to get better surface

height measurement, contaminated waveforms should be retracked against geophysical corrections. In this paper, an improved threshold retracker (ITR) is developed to retrack waveforms over lakes. ITR considers not only the physical characteristics of the reflecting surface, but also the stochastic feature of waveform, and two new retrackers, the N-Beta function model, and the N-5-Beta function model, are also put forward to develop the waveform retracking program of this study. TOPEX/POSEIDON waveforms over Hulun Lake in the North China are retracked to monitor the temporal lake level variations. A comparison with the in situhydrological data indicates ITR is very efficient to monitor the lake level variations with the retracked altimetric data. The result of our study shows accurate seasonal level variations and the descending trend of Hulun Lake. [J1134]

"Fast and Adaptive Method for SAR Superresolution Imaging Based on Point Scattering Model and Optimal Basis Selection"

A novel fast and adaptive method for synthetic aperture radar (SAR) superresolution imaging is developed. Based on the point scattering model in the phase history domain, a dictionary is constructed so that the superresolution imaging process can be converted to a problem of sparse parameter estimation. The approximate orthogonality of this dictionary is exploited by theoretical derivation and experimental verification. Based on the orthogonality of the dictionary, we propose a fast algorithm for basis selection. Meanwhile, a threshold for obtaining the number and positions of the scattering centers is determined automatically from the inner product curves of the bases and observed data. Furthermore, the sensitivity of the threshold on estimation performance is analyzed. To reduce the burden of mass calculation and memory, a simplified superresolution imaging process is designed according to the characteristics of the imaging parameters. The experimental results of the simulated images and an MSTAR image illustrate the validity of this method and its robustness in the case of the high noise level. Compared with the traditional regularization method with the sparsity constraint, our proposed method suffers less computation complexity and has better adaptability. [J1135]

"Longshore Surface Currents Measured by Doppler Radar and Video PIV Techniques"

Mean longshore surface currents within the surf zone were measured using two remote sensing techniques: microwave Doppler radar and optical video. Doppler radar relies on small-scale surface roughness that scatters the incident electromagnetic radiation so that velocities are obtained from the Doppler shift of the backscattered radiation. Video relies on texture and contrast of scattered sunlight from the sea surface, and velocity estimates are determined using particle imaging velocimetry (PIV). This paper compares video PIV and Doppler radar surface velocities over a 1-km alongshore by 0.5-km cross-shore area in the surf zone of a natural beach. The two surface velocity estimates are strongly correlated (R2ges 0.79) over much of the surf zone. Estimates differ at the outer edge of the surf where strong breaking is prevalent, with radar-estimated velocities as much as 50% below the video estimates. The radar and PIV velocities at particular locations in the surf zone track each other well over a 6-h period, showing strong modulations in the mean alongshore flow occurring on 10-20-min time intervals. In one case, both systems observe a strong eddy-like mean flow pattern over a 200-m section of coastline, with the mean alongshore current changing direction at about the mid surf zone. The good spatial and temporal agreement between the two remote measurement techniques, which rely on very different mechanisms, suggests that both are reasonably approximating the true mean longshore surface velocity. [J1136]

"GPR Response From Buried Pipes: Measurement on Field Site and Tomographic Reconstructions"

The identification of the physical nature of an object or target causing a ground-penetrating radar (GPR) anomaly, as well as the estimation of a target's dimensions and geometry, is rather challenging. To improve target identification, basic studies are still required, and they can be addressed primarily using a laboratory- or field-based physical model. The field model (test site) is usually expensive and difficult to build, but it provides data for controlled target properties and geometry from a natural environment that are essential for testing processing techniques. In this paper, we present the results from a field experiment where GPR data were collected on plastic and metallic pipes. The main objective is the comparison of the classical migration technique with a microwave tomography approach for reconstructing the geometrical target properties. The use of the microwave tomography approach will allow us to obtain more focused and stable images of the buried objects compared to the ones obtained using classical migration techniques. [J1137]

"Coherence-Improving Algorithm for Image Pairs of Bistatic SARs With Nonparallel Trajectories"

Ground moving target indication (GMTI) is one of the most important applications in a general bistatic synthetic aperture radar (SAR) system, where the transmitter and receiver move along nonparallel trajectories with different velocities. In order to improve the capability of clutter cancellation in bistatic SAR/GMTI processing, the coherence between two echoes collected by two receivers is investigated, and the full-coherence conditions are

derived. A new coherence-improving algorithm for general bistatic SAR complex image pairs is proposed, which can be realized in the following steps: 2-D range azimuth prefiltering processing, relative geometric deformation correction, and image registration. An approximate implementation of 2-D prefiltering and the corresponding prefilter parameter analysis are also given. Last, two numerical experiment results are given to demonstrate the effectiveness of the proposed algorithm. [J1138]

"Approximate Cramer-Rao bound on Doppler error in correlation-processing relatively narrowband noise radar"

Limitations on accuracy of Doppler estimation in continuous-wave noise radar with correlation processing are studied. Second-order properties of output of the correlation receiver are evaluated and an approximate Cramer-Rao bound on errors of Doppler measurement is derived. The accuracy of Doppler measurements is found to be affected by the following factors: power spectral density of noise signal, frequency response of the low-pass filter in correlator, observation time, velocity of the target and signal to noise ratio. It is shown that the random nature of the transmitted signal induces additional fluctuations at the output of correlator which limit the accuracy even in the infinite signal to noise case. Qualitative extension of the results to a case covering multiple targets and clutter is made. It is argued that the performance will decrease and that increasing transmitted power may not provide significant improvement when clutter is present. [J1139]

"Raw signal processing of stripmap bistatic synthetic aperture radar"

Under the translational invariant (TI) configuration of stripmap imaging bistatic synthetic aperture radar (BISAR), the frequency domain expression of signal model is developed. Two forms, with an approximation of extracting the range dependence and an accurate iterative solution, as well as their respective focusing methods, that is the approximated solution method and the iterative solution method are presented here. The range-Doppler method is extended to the TI configuration of BISAR. Imaging simulation of the point targets and comparison with the bistatic backprojection method shows the feasibility of these methods as well as their merits and demerits. [J1140]

"Extraction of mixed-order multicomponent ship target signals from broadened sea clutter in bistatic shipborne surface wave radar"

A dynamic geometry model was built to describe the Doppler-broadening characteristics of the first-order Bragg lines for bistatic shipborne surface wave radar. They are time-varying because the Doppler frequency shifts of sea echoes are simultaneously modulated by the velocity components projected from the unavoidably different motions of both platforms, which is more complex than its counterpart in the monostatic mode. The geometrical relation is used to obtain the received signal model: strong first-order sea clutter interferences and submerged ship targets with constant and non-constant speeds are considered as mixed-order multicomponent polynomial-phase signals (mc-PPSs) and both second-order sea clutter continuum and atmospheric noise as additive noise. Then, a scheme based on the product high-order ambiguity function is proposed to extract the targets; it is a recursive procedure in which the first-order sea clutter is removed by an existing time-space cascaded filtering method. Monte Carlo simulations show the validity and efficiency of the proposed scheme. [J1141]

"Space-time constant modulus algorithm for multipath removal on the reference signal exploited by passive bistatic radar"

The authors address the problem of multipath cancellation in the reference signal used in passive bistatic radar (PBR), which exploits an existing transmitter as emitter of opportunity. The presence of multipath echoes in the reference signal is demonstrated to strongly affect the detection performance of passive radar. Based on the well-known constant modulus algorithm (CMA) approach in the time-domain, new multi-dimensional techniques are considered for the adaptive equalisation of the reference signal based on an array of antennas and multiple receiving channels. The effectiveness of these techniques for PBR purposes is demonstrated with reference to typical simulated scenarios. The considered strategies, addressed as space-CMA and space-time-CMA, are shown to be able to recover the performance loss because of the multipath contribution in the reference signal so that they appear as very appealing solutions for PBR equipped with an array of antennas and multiple receiving channels. [J1142]

"H.L. Van Trees (ed.) and K.L. Bell (ed.), Bayesian Bounds for parameter estimation and nonlinear filtering/tracking, Wiley & Sons Ltd, 2007 [JBook review]"

Parameter and random-process estimation play a central role in signal processing. A common requirement in the estimation problems is to predict and/or evaluate the error performance. This task is often complicated because

the system and measurement models are typically non-linear with some inherent uncertainty. The error performance prediction is supposed to be theoretical-its goal is to establish the best achievable limit and is to be carried out even before one develops a suitable estimator. The error performance evaluation is usually done by Monte Carlo simulations once a candidate estimator has been built. Evaluation serves to assess the estimator quality by comparing its actual error with the theoretical prediction. The fundamental question in algorithm design is "Can we do better?" In this context, it is of paramount importance to find a theoretical bound on the error performance and compare it against the performance of various sub-optimal candidate estimators. [J1143]

"Direction finding in spatially correlated noise fields with arbitrarily-spaced and far-separated subarrays at unknown locations"

A computationally simple azimuth-elevation direction finding algorithm in spatially correlated noise fields using two-far-separated subarray geometry (Li etal.1995) is presented. We assume one subarray consists of multiple acoustic vector sensors, while another subarray comprises multiple pressure sensors. All sensors are arbitrarily placed at unknown locations. The authors firstly define a cross matrix to eliminate the effect of the spatially correlated noise. Then the so-called propagator method is used to estimate the steering vectors of acoustic vector sensors. Finally, a closed form, automatically paired azimuth-elevation angle estimates are derived. The proposed algorithm requires no eigen decomposition into signal or noise subspaces. In addition, the proposed algorithm does not need 2D iterative searching. Therefore the algorithm shows low computational complexity. Monte Carlo simulations are presented to verify the effectiveness of the proposed algorithm. [J1144]

"Range sidelobes blanking by comparing outputs of contrasting mismatched filters"

Range sidelobes, a major shortcoming of radar pulse compression, are often reduced through the use of mismatched filters. The authors propose to blank the remaining sidelobes by using two or more mismatched filters, whose sidelobes are designed to peak at different delays. The authors show how to design such filters and present promising simulation results with two or more mismatched filters. [J1145]

"Dual update-rate carrier tracking technique for new generation global navigation satellite system signals in dynamic environments"

With the upcoming of modernised Global Positioning System (GPS) and Galileo, the new generation global navigation satellite systems (GNSSs) will be able to provide the users a better positioning performance. An important modification on most of the new generation GNSS signal structures is the availability of the pilot channel, which stands for an additional measurement obtained; moreover, a pure phase-locked loop (PLL) can be used in carrier-phase tracking loop. Utilising this characteristic, the authors present a dual update-rate PLL for modernised GNSS signals to deal with the well-known dilemma that the usage of long coherent integral time can help in reducing the noise from thermal effects, whereas the usage of short coherent integral time can permit the tracking loop to suffer more dynamics stress. By processing data and pilot channels with different coherent integral times, different discriminators, and then performing the fusion of those two different update-rate measurements in a Kalman-filter-based loop filter, this loop offers several advantages over the traditional methods in dynamic and low carrier-to-noise ratio (CNR) environments. Simulation results demonstrate that the proposed dual update-rate PLL shows good performance in both dynamic and low CNR environments. [J1146]

"Image denoising using 2-D separable oversampled DFT modulated filter banks"

The direction-frequency selectivity of two-dimensional (2-D) separable oversampled discrete Fourier transform (DFT) modulated filter banks, showing that such 2-D filter banks can provide fine frequency tiling and efficient image representations with direction-frequency selectivity, is analysed. Moreover, the doubly local Wiener filtering is extended to the case using two 2-D separable oversampled DFT modulated filter banks, where the empirical subband energy distributions of the image are estimated by the two sets of directional windows matching the direction-frequency selectivity of the subband filters. The proposed algorithm is of low computational complexity and exhibits a great capability to preserve inhomogeneous textures, owing to the fact that 2-D separable DFT modulated bases are suited to represent oscillating patterns in images. The experimental results show that the proposed denoising algorithm is competitive with the existing algorithms with comparable computational complexity. Particularly, for images with abundant inhomogenous texture, it gives larger output peak signal-to-noise ratios (PSNRs) and achieves better visual effect in texture regions of images. [J1147]

"Sparse Power Angle Spectrum Estimation"

A novel method for estimating the power angle spectrum (PAS) is presented that decomposes the true PAS into

a small set of basis functions. The basis coefficients for this sparse representation are found by enforcing equality to the covariance or Bartlett PAS subject to a minimum lscr1-norm constraint. The method, referred to as sparse PAS estimation (SPASE), can be implemented conveniently using existing linear-programming (LP) solvers. Further, because only a few clusters are required in the representation, the method enables reduced-complexity stochastic models for the channel and possibly allows reduced overhead in channel feedback schemes. Application of the method to simulated channels and multiple-input multiple-output (MIMO) propagation data demonstrates the utility of the method. [J1148]

"Phase of Target Scattering for Wetland Characterization Using Polarimetric C-Band SAR"

Wetlands continue to be under threat, and there is a major need for mapping and monitoring wetlands for better management and protection of these sensitive areas. Only a few studies have been published on wetland characterization using polarimetric synthetic aperture radars (SARs). The most successful results have been obtained using the phase difference between HH and VV polarizations, phiHH- phiVV, which has shown promise for separating flooded wetland classes. Recently, we have introduced a new decomposition, the Touzi decomposition, which describes target scattering type in terms of a complex entity, the symmetric scattering type. Huynen's target helicity is used to assess the symmetric nature of target scattering. In this paper, the new complex-scattering-type parameters, the magnitude alphasand phase Phialphas, are investigated for wetland characterization. The use of the dominant-scattering-type phase Phialphasmakes it possible to discriminate shrub bogs from poor (sedge or shrub) fens. These two classes cannot be separated using phiHH- phiVV, or the radiometric scattering information provided by alphas, the Cloude alpha, the entropy H, and the multipolarization HH-HV-VV channels. phialphas, which cannot detect deep (45 cm below the peat surface) water flow in a bog, is more sensitive to the shallower (10-20-cm) fen beneath water, and this makes possible the separation of poor fens from shrub bogs. Phialphasalso permits the discrimination of conifer-dominated treed bog from upland deciduous forest under leafy conditions. Target helicity information is exploited to introduce a new parameter, the target asymmetry. The latter is shown very promising for detection of forest changes between leafy and no-leaf conditions. The analysis of low-entropy marsh scattering showed that both the scattering-type magnitude and phas--e alphasand Phialphas, respectively, as well as the maximum polarization intensity of the dominant scattering m, are needed for a better understanding of marsh complex scattering mechanisms. The unique information provided by the new roll-invariant decomposition parameters are demonstrated using repeat-pass Convair-580 polarimetric C-band SAR data collected in June and October 1995 over the RAMSAR Mer Bleue wetland site near Ottawa (Canada). [J1149]

"Layover Solution in SAR Imaging: A Statistical Approach"

In this letter, a statistical-based approach to recover layover solution in synthetic aperture radar (SAR) images is proposed. The aim of this letter is to develop a methodology in order to separate different scattering contributions collapsed in a single SAR image pixel. After a brief discussion about layover, the proposed model is presented, followed by a discussion about achievable performances using Cramer-Rao lower bounds. In the final part of this letter, the performances of a maximum likelihood estimator are evaluated in a simulated data scenario, showing the effectiveness of the method. [J1150]

"Performance of the adaptive generalised matched subspace constant false alarm rate detector in non-Gaussian noise: an experimental analysis"

The authors deal with the performance analysis of an adaptive version of the generalised matched subspace detector (GMSD) in compound-Gaussian clutter with unknown covariance matrix. The original GMSD was proposed to detect subspace signals in compound-Gaussian noise with known covariance matrix and ensures the constant false alarm rate (CFAR) property. In real situations, this assumption is unrealistic, which means that the covariance matrix must be estimated from training data. The authors use a robust estimate of the covariance matrix called the fixed-point estimate, recently proposed in the literature. The performance of the obtained adaptive detector, in terms of CFAR behaviour and probability of detection, is evaluated in the presence of real sea clutter data, collected by the McMaster IPIX radar. [J1151]

"Estimation of the Equivalent Number of Looks in Polarimetric Synthetic Aperture Radar Imagery"

This paper addresses estimation of the equivalent number of looks (ENL), an important parameter in statistical modeling of multilook synthetic aperture radar (SAR) images. Two new ENL estimators are discovered by looking at certain moments of the multilook polarimetric covariance matrix, which is commonly used to represent multilook polarimetric SAR (PolSAR) data, and assuming that the covariance matrix is complex Wishart distributed. First, a second-order trace moment provides a polarimetric extension of the ENL definition and also a matrix-variate version of the conventional ENL estimator. The second estimator is obtained from the log-

determinant matrix moment and is also shown to be the maximum likelihood estimator under the Wishart model. It proves to have much lower variance than any other known ENL estimator, whether applied to single-polarization or PolSAR data. Moreover, this estimator is less affected by texture and thus provides more accurate results than other estimators should the assumption of Gaussian statistics for the complex scattering coefficients be violated. These are the first known estimators to use the full covariance matrix as input, rather than individual intensity channels, and therefore to utilize all the statistical information available. We finally demonstrate how an ENL estimate can be computed automatically from the empirical density of small sample estimates calculated over a whole scene. We show that this method is more robust than procedures where the estimate is calculated in a manually selected region of interest. [J1152]

"Mine Classification With Imbalanced Data"

In many remote-sensing classification problems, the number of targets (e.g., mines) present is very small compared with the number of clutter objects. Traditional classification approaches usually ignore this class imbalance, causing performance to suffer accordingly. In contrast, the recently developed infinitely imbalanced logistic regression (IILR) algorithm explicitly addresses class imbalance in its formulation. We describe this algorithm and give the details necessary to employ it for remote-sensing data sets that are characterized by class imbalance. The method is applied to the problem of mine classification on three real measured data sets. Specifically, classification performance using the IILR algorithm is shown to exceed that of a standard logistic regression approach on two land-mine data sets collected with a ground-penetrating radar and on one underwater-mine data set collected with a sidescan sonar. [J1153]

"Ensemble Kalman filter"

Meteorological models are used to predict the weather, study atmospheric processes, and provide input to decision makers on the consequences of increased greenhouse gas emissions to the Earth's climate. Predictions of future atmospheric states are accomplished as an initial value or marching problem, where the initial atmospheric state is specified and the variables are advanced in time using numerical techniques. The challenge of data assimilation in meteorology is to estimate, based on a set of limited observations of varying types, the complete three-dimensional atmospheric state at a given time to provide an initial value for a meteorological model. [J1154]

"A New Range Finder Based on a Four-Port Junction"

The design and performance of a prototype range finder based on a four-port junction are presented. The four-port junction is used as a precision phase detector. The system proposed presents advantages such as compact size, low cost, low consumption, and low computational time. The principle of operation, the sensor and the results are described in this paper. [J1155]

"Effectiveness of 2-D and 2.5-D FDTD Ground-Penetrating Radar Modeling for Bridge-Deck Deterioration Evaluated by 3-D FDTD"

Computational modeling effectively analyzes the wave propagation and associated interaction within heterogeneous reinforced concrete bridge decks, providing valuable information for sensor selection and placement. It provides a good basis for the implementation of the inverse problem in defect detection and the reconstruction of subsurface properties, which is beneficial for defect diagnosis. The objective of this study is to evaluate the effectiveness of lower order models in the evaluation of bridge-deck subsurfaces modeled as layered media. The two lower order models considered are a 2-D model and a 2.5-D model that uses the 2-D geometry with a compressed coordinate system to capture wave behavior outside the cross-sectional plane. Both the 2- and 2.5-D models are compared to the results obtained from a full 3-D model. A filter that maps the 3-D excitation signal appropriately for 2- and 2.5-D simulations is presented. The 2.5-D model differs from the 2-D model in that it is capable of capturing 3-D wave behavior interacting with a 2-D geometry. The 2.5-D matches results from the corresponding 3-D model when there is no variation in the third dimension. Computational models for air-launched ground-penetrating radar with 1-GHz central frequency and bandwidth for the detection of bridge-deck delamination are implemented in 2-, 2.5-, and 3-D using FDTD simulations. In all cases, the defect is identifiable in the results. Thus, it is found that in layered media (such as bridge decks) 2- and 2.5-D models are good approximations for modeling bridge-deck deterioration, each with an order of magnitude reduction in computational time. [J1156]

"A Hybrid Conditional Random Field for Estimating the Underlying Ground Surface From Airborne LiDAR Data"

Recent advances in airborne light detection and ranging (LiDAR) technology allow rapid and inexpensive generation of digital surface models (DSMs), 3-D point clouds of buildings, vegetations, cars, and natural terrain features over large regions. However, in many applications, such as flood modeling and landslide prediction, digital terrain models (DTMs), the topography of the bare-Earth surface, are needed. This paper introduces a novel machine learning approach to automatically extract DTMs from their corresponding DSMs. We first classify each point as being either ground or nonground, using supervised learning techniques applied to a variety of features. For the points which are classified as ground, we use the LiDAR measurements as an estimate of the surface height, but, for the nonground points, we have to interpolate between nearby values, which we do using a Gaussian random field. Since our model contains both discrete and continuous latent variables, and is a discriminative (rather than generative) probabilistic model, we call it a hybridconditionalrandomfield. We show that a Maximum aPosterioriestimate of the surface height can be efficiently estimated by using a variant of the Expectation Maximization algorithm. Experiments demonstrate that the accuracy of this learning-based approach outperforms the previous best systems, based on manually tuned heuristics. [J1157]

"GLRT Versus MFLRT for Adaptive CFAR Radar Detection With Conic Uncertainty"

In this paper, we consider the problem of detecting an unknown signal, belonging to a conic region, in the presence of complex Gaussian disturbance. We assume that the cone aperture parameter, which ranges in a pre-assigned interval, is unknown. Hence, we devise two decision rules which are respectively based on the Generalized Likelihood Ratio Test (GLRT) and on the Multifamily Likelihood Ratio Test (MFLRT). Both the receivers ensure the Constant False Alarm Rate (CFAR). At the analysis stage, we compare the performance of the two decision strategies in correspondence of different parameters for the useful signal component. [J1158]

"Performance analysis of interrupted sparse HFSWR waveform coded with successive fast Fourier transforms"

A successive Fourier transform technique is applied to efficiently generate an interrupted sparse waveform for a monostatic high-frequency surface wave radar. With few iterations a good stop to passband ratio is reached, and it is show that, when using an optimised envelope, a better average and a lower standard deviation are obtained in terms of minimal contrast ratio than in the case of a simple train of pulses. [J1159]

"Electromagnetic Design and Realization of Innovative Fiber-Reinforced Broad-Band Absorbing Screens"

This paper presents the design and the realization process for radar absorbing panels made of composite materials. It is demonstrated that the proper selection of the carbon fiber length and volume fraction allows reducing sensibly the overall thickness of the screen compared to a standard absorber, and obtaining at the same time broad-band absorption response in the X- and Ku-bands. To this end, the carbon fiber composite material realizing the lossy sheet of the absorbing screen is designed by simulation in order to have tailored complex effective permittivity. Two prototypes of absorbing screens are realized and tested experimentally. The first one is a three-layer panel, characterized by reflection coefficient lower than -10 dB in the frequency range from 8 to 14 GHz, and total thickness of 4.5 mm. The second one is a five-layer panel with reflection coefficient less than -20 dB in the range 9-18 GHz, and total thickness of 5.5 mm. [J1160]

"AMCs for ultra-thin and broadband RAM design"

A novel methodology for ultra-thin and broadband radar absorbing material (RAM) design is proposed. The method is based on periodically arranging two different types of thin planar slabs that are both artificial magnetic conductors (AMCs) with different phase characteristics that are arranged in a checkerboard configuration. By controlling the phase difference between the two types of AMC slabs, the energy which is normally incident on the screen is redirected, and the RCS along the boresight is reduced over a wide frequency range. [J1161]

"Conditioning Stochastic Rainfall Replicates on Remote Sensing Data"

Temporally and spatially variable rainfall replicates are frequently required in hydrologic applications of ensemble forecasting and data assimilation. Ensemble methods can be expected to work better when the rainfall replicates more closely resemble observed storms. In particular, the replicates should capture the intermittency and variability that are dominant features of rainfall events. In this paper, we present a new probabilistic procedure for generating realistic rainfall replicates that are constrained by (or conditioned on) remote sensing measurements. The procedure uses remotely sensed cloud top temperatures to identify potentially rainy regions. The cloud top temperatures are obtained from visible/infrared instruments in geostationary orbit. A multipoint geostatistical algorithm generates areas of nonzero rain (rain clusters) within each cloudy region. This algorithm relies on

statistics derived from ground-based weather radar [National Operational Weather Radar (NOWRAD)] data. A truncated multiplicative cascade generates rain rates within each rain cluster. A computational experiment based on summer 2004 data from the Central U.S. indicates that the rainfall replicates simulated by the procedure are visually and statistically similar to individual NOWRAD images and to a large ensemble of NOWRAD images collected throughout the summer simulation period. [J1162]

"A Millimeter-Wave (40-45 GHz) 16-Element Phased-Array Transmitter in 0.18- m SiGe BiCMOS Technology"

This paper demonstrates a 16-element phased-array transmitter in a standard 0.18-mum SiGe BiCMOS technology for Q-band satellite applications. The transmitter array is based on the all-RF architecture with 4-bit RF phase shifters and a corporate-feed network. A 1:2 active divider and two 1:8 passive tee-junction dividers constitute the corporate-feed network, and three-dimensional shielded transmission-lines are used for the passive divider to minimize area. All signals are processed differentially inside the chip except for the input and output interfaces. The phased-array transmitter results in a 12.5 dB of average power gain per channel at 42.5 GHz with a 3-dB gain bandwidth of 39.9-45.6 GHz. The RMS gain variation is < 1.3 dB and the RMS phase variation is < for all 4-bit phase states at 35-50 GHz. The measured input and output return losses are < -10 dB at 36.6-50 GHz, and <-10 dB at 37.6-50 GHz, respectively. The measured peak-to-peak group delay variation is plusmn 20 ps at 40-45 GHz. The output P-1dBis -5plusmn1.5 dBm and the maximum saturated output power is-2.5plusmn1.5 dBm per channel at 42.5 GHz. The transmitter shows <1.8 dB of RMS gain mismatch and < 7deg of RMS phase mismatch between the 16 different channels over all phase states. A-30 dB worst-case port-to-port coupling is measured between adjacent channels at 30-50 GHz, and the measured RMS gain and phase disturbances due to the inter-channel coupling are < 0.15 dB and < 1deg, respectively, at 35-50 GHz. All measurements are obtained without any on-chip calibration. The chip consumes 720 mA from a 5 V supply voltage and the chip size is 2.6times3.2 mm2. [J1163]

"An Examination of the Validity of the Mean Raindrop-Shape Model for Dual-Polarization Radar Rainfall Retrievals"

Information about the shape of raindrops is critical for the retrieval of rainfall rate from dual-polarization radar measurements. As described in the literature, the relation describing drop oblateness as a function of its equivolumetric diameter is nonlinear. There are several relations that express the shape-size dependence as a nonlinear fourth-order polynomial that has five coefficients or 5 DOF. While these are important for studying raindrop shape, it is not clear that they are needed to estimate an integral quantity such as rainfall rate. This paper examines the validity of using a simple equivalent linear shape-size model based on the principle of the mean-value theorem for estimating rain from dual-polarization radar measurements. Assuming Rayleigh-Gans scattering for spheroids to describe raindrop scattering and drop oblateness described by a linear relation between axis ratio and equivolumetric diameter, a general self-consistency equation relating reflectivity factor, differential reflectivity, specific differential phase shift, and slope of the shape-size relation is obtained for each radar operating frequency. In this 4-D space, relations for estimating rainfall rate without requiring an assumption of a specific drop-shape model from polarimetric radar measurements were obtained. To study all the implications arising from electromagnetic and microphysical aspects, reconstructed rain and radar measurement profiles obtained from real radar observations were used to test the performance of the proposed rain estimation procedure. The performance is compared with algorithms derived assuming specific a priori fixed drop-shape-size relations expressed by a fourth-order polynomial. Results show that, in general, the proposed rain algorithms perform better or at least equal to the algorithms derived assuming a priori fixed shape-size models, demonstrating that the prevailing model directly derived from data is suitable for rainfall retrieval purposes. [J1164]

"Integrated Receiver Including Both Receiver Channel and TDC for a Pulsed Time-of-Flight Laser Rangefinder With cm-Level Accuracy"

An integrated receiver that includes both the time-to-digital converter (TDC) and the receiver channel and is intended for a pulsed time-of-flight laser rangefinder with a measurement range of approximately 10 m has been designed and fabricated in a standard 0.13 mum CMOS process. The receiver operates by detecting the current pulse of an optical detector and producing a stop timing mark for the TDC by means of a leading edge timing discriminator. The TDC is used to measure the actual time interval between the start and stop pulses and the slew-rate of the stop pulse, to compensate for a walk error produced in the discriminator. The single-shot precision of the whole receiver is 250 ps for a minimum detectable signal, and its accuracy and power consumption are plusmn 37 ps with compensation within a dynamic range of at least 1:10,000 and less than 45 mW, respectively. The size of the die is 1300 mum times1300 mum including pads. [J1165]

"Time waits for no engineer"

How would you have arranged a radar array to protect London during the Blitz? How do you lower a drawbridge without crashing it, using only medieval technology? How can you build a pyramid out of massive stones using only sand, clay, and ropes? And how do you inveigle kids, 7 to 17, into tackling such questions? Game designer [J1166]

"Retrieval of Cloud Optical Properties From Multiple Infrared Hyperspectral Measurements: A Methodology Based on a Line-by-Line Multiple-Scattering Code"

A methodology to retrieve cloud optical properties using high spectral resolution (HSR) infrared (IR) measurements is presented. This new method has the ability to easily adapt to multiple instruments and viewing angles. The retrieval uses a line-by-line multiple-scattering simulation and HSR IR measurements to retrieve spectrally resolved cloud optical depths (ODs). The spectral ODs are compared to a precomputed OD database generated from an ensemble of cloud particle-size distributions and precomputed single-scattering and single-particle optical properties for a variety of ice-crystal habits. Cloud microphysics are retrieved by finding the closest fit to the database. Results are independent of first-guess optical property assumptions on size and habit. The retrieval method has been applied to aircraft, satellite, and uplooking HSR measurements with results evaluated against coincident HSR lidar and radar measurements. Analysis of retrieval errors produced by assumptions and uncertainties in the atmospheric state demonstrates different sensitivities to atmospheric parameters when uplooking or downlooking data are analyzed. For both viewing geometries, the retrieval is most sensitive to the uncertainties in the assumed cloud boundaries. It is also found that nonuniform vertical distribution of cloud OD can result in significant biases in the IR retrieved cloud ODs. [J1167]

"Radar Response of Firn Exposed to Seasonal Percolation, Validation Using Cores and FDTD Modeling"

We use ground-penetrating radars (GPRs), firn cores, and electromagnetic finite-difference time-domain (FDTD) numerical modeling to characterize the GPR response to a frozen high-arctic firn pack. As a result of extensive summertime percolation, the firn pack comprises a high fraction of ice layers, lenses, and vertical glands. We show that the GPR response on the firn pack mainly depends on the following: (1) the thickness of the ice layers; (2) the distance between layers; (3) the layer roughness; and (4) the presence or absence of elliptical ice lenses. Using 3-D FDTD modeling, we show that the GPR is not sensitive to typical ice glands, which implies that the GPR underestimates firn heterogeneity, such that firn stratigraphy in percolation and wet-snow zones could be incorrectly interpreted as being better preserved than it actually is. We find that thin ice layers (< 0.05 m) or multiple thin ice layers give a strong response. Thicker ice layers typically give a weaker backscatter per unit area, mainly due to the lack of interference of the reflections from the upper and lower interfaces, but are, due to their continuity, easily trackable. Ice layers with a thickness comparable to the GPR wavelength give 180deg phase-shifted upper and lower reflections and are, in general, separated by a band of low GPR response, due to the lack of permittivity contrast within the ice layers. Despite the ice lenses' relatively short horizontal correlation length, as inferred from cores, bands of high-amplitude clutter caused by these features can be traced over several kilometers in GPR profiles. [J1168]

"The LTE link-layer design"

The LTE radio interface for 3GPP Release 8 was specified recently. This article describes the LTE link-layer protocols, which abstract the physical layer and adapt its characteristics to match the requirements of higher layer protocols. The LTE link-layer protocols are optimized for low delay and low overhead and are simpler than their counterparts in UTRAN. The state of- the-art LTE protocol design is the result of a careful crosslayer approach where the protocols interact with each other efficiently. This article provides a thorough overview of this protocol stack, including the sub-layers and corresponding interactions in between them, in a manner that is more intuitive than in the respective 3GPP specifications. [J1169]

"A Low-Power and Small-Size HF Backscatter Radar for Ionospheric Sensing"

A new high-frequency backscatter radar (Wuhan Ionospheric Oblique Backscattering Sounding System) for ionospheric sensing and study has been developed. With the new system design, oblique backscatter sounding and oblique sounding can be achieved in this radar just through simply loading appropriate software. Furthermore, due to alternate transmission and reception in equal interval, this radar can detect the ionospheric state in the range of a few thousand kilometers and achieve the largest gain of applied pseudorandom sequences. In addition, this radar usually obtains 27-dB gain from phase coded pulse compression and 21-dB gain from coherent spectral integration using pseudorandom code, pulse compression, and coherent spectral

integration techniques. This radar also exploits merits of Peripheral component interconnect eXtensions for Instruments (PXI) bus technology and is designed as a modular and compact PXI-based system. Details of system design, sounding timing, and signal-processing algorithm are described. Except for the antenna systems and power amplifier, this radar's dimension is 177.8 times 431.8 times 457.2 mm. With this radar, the oblique backscatter ionogram and Dopplerionogram can be clearly obtained in the range of a few thousand kilometers with 100-W power. The oblique ionogram for propagation over a distance of several kilometers can also be clearly acquired at the time of oblique backscatter sounding. The initial observations obtained with this radar are included to demonstrate its performance. [J1170]

"Optimal Threshold Policies for Multivariate POMDPs in Radar Resource Management"

This paper deals with the management of multimode sensors such as multifunction radars. We consider the problems of multitarget radar scheduling formulated as multivariate partially observed Markov decision process (POMDPs). The aim is to compute the scheduling policy to determine which target to choose and how long to continue with this choice so as to minimize a cost function. We give sufficient conditions on the cost function, dynamics of the Markov chain target and observation probabilities so that the optimal scheduling policy has a threshold structure with respect to the multivariate TP2 ordering. This implies that the optimal parameterized policy can be estimated efficiently. We then present stochastic approximation algorithms for estimating the best multilinear threshold policy. [J1171]

"Estimating Spatiotemporal Ground Deformation With Improved Permanent-Scatterer Radar Interferometry"

Synthetic aperture radar interferometry has been applied widely in recent years to ground deformation monitoring although difficulties are often encountered when applying the technology, among which the spatial and temporal decorrelation and atmospheric artifacts are the most prominent. The permanent-scatterer interferometric synthetic aperture radar (PS-InSAR) technique has overcome some of the difficulties by focusing only on the temporally coherent radar targets in a time series of synthetic aperture radar (SAR) images. This paper presents an improved PS-InSAR technique by introducing PS-neighborhood networking and empirical mode decomposition (EMD) approaches in the PS-InSAR solution. Linear deformation rates and topographic errors are estimated based on a least squares method, while the nonlinear deformation and atmospheric signals are computed by singular value decomposition and the EMD method. An area in Phoenix, AZ, is used as a test site to determine its historical subsidence with 39 C-band SAR images acquired by European Remote Sensing 1 and 2 satellites from 1992 to 2000. [J1172]

"Autobinomial Model for SAR Image Despeckling and Information Extraction"

This paper presents a model-based despeckling (MBD) of synthetic aperture radar (SAR) images using Bayesian analysis. The SAR image is despeckled using first-order Bayesian inference. The novelty in this paper is an autobinomial model (ABM), which models a priorprobability density function (pdf); meanwhile, the likelihoodpdf is modeled as a gamma distribution. Analytically, a solution for a maximum aposterioriestimate using an autobinomial prior cannot be computed; therefore, an approximation is introduced using differential. The best ABM for approximating the texture parameters in SAR images is found by using second-order Bayesian inference. The edges in the SAR images are detected using region borders, which have statistically different properties. Coefficient of variation is used to distinguish between homogeneous and heterogeneous areas. The experimental results show that the proposed method preserves the textural features and removes noise significantly in the homogeneous and heterogeneous regions. The proposed despeckling method is good regarding objective measures for synthetic images and better despeckles the real SAR images, when compared with the state-of-the-art MBD methods. [J1173]

"Electromagnetic Scattering Characteristics of PEC Targets in the Terahertz Regime"

Electromagnetic (EM) scattering characteristics of perfectly electrical conducting (PEC) targets in the terahertz (THz) frequency range are investigated through the use of ray-based high-frequency EM techniques. These techniques include the methods of shooting and bouncing rays (SBR), and the truncated-wedge incremental-length diffraction coefficients (TW-ILDCs). The EM fields associated with each ray are tracked and computed, based on the principle of physical optics (PO) and/or geometrical optics (GO). The total field scattered from the PEC target is then obtained by summing up the EM contributions of each ray and each illuminated edge. In contrast to previously reported applications, these methods are combined together to solve three-dimensional (3D) scattering problems in the THz region. Due to the use of analytical formulas of physical optics and the truncated-wedge incremental-length diffraction coefficients method, the consideration of the multi-reflection effect in shooting and bouncing rays, and partially accounting for the second-order edge-diffraction effects in the

truncated-wedge incremental-length diffraction coefficients method, we obtain an extremely efficient algorithm for studying THz scattering. It has excellent agreement with an accurate integral solver, the multilevel fast multipole algorithm (MLFMA), which cannot be used in handling large-scale THz problems. Both mono- and bistatic radar cross sections (RCS) of several PEC objects in the THz band are given to show the correctness and reliability of the asymptotic methods. The EM scattering characteristics of such targets in the THz region are analyzed. Great differences of the target characteristics between the THz and GHz regimes are observed and discussed. [J1174]

"Adaptive mobile spot diffusing angle diversity MC-CDMA optical wireless system in a real indoor environment"

In this paper, we introduce a mobile optical wireless (OW) multicarrier-code division multiple access (MC-CDMA) system that employs a new adaptive line strip multibeam system (ALSMS) with diversity detection. Our results indicate that a significant improvement in the bit error rate (BER) can be obtained in the presence of very directive noise, multipath propagation and shadowing typical in a real indoor environment. With transmitter and/or receiver mobility, ALSMS can improve the BER performance by almost 10-5with 2 active users, and increase the signal-to-noise ratio (SNR) by more than 13 dB compared to the unadaptive LSMS. [J1175]

"Large-Area Soil Moisture Estimation Using Multi-Incidence-Angle RADARSAT-1 SAR Data"

The sensitivity of synthetic aperture radar (SAR) backscatter to soil moisture has been adequately established. However, monitoring of soil moisture over large agricultural areas is still difficult because SAR backscatter is also sensitive to other target properties like surface roughness, crop cover, and soil texture (soil type), along with its strong sensitivity to soil moisture. Hence, to develop a methodology for large-area soil moisture estimation using SAR, it is necessary to incorporate the effects of surface roughness, crop cover, and soil texture in the soil moisture retrieval model. In this paper, a methodology for soil moisture estimation over a large area is developed using a pair of low- and high-incidence-angle RADARSAT-1 SAR data over parts of Agra, Mathura, and Bharatpur districts, India, during March 1999. The methodology requires acquisition of synthetic aperture radar data at low and high incidence angles, such that the soil moisture changes are negligible between the two acquisitions. In order to demonstrate the applicability of the developed methodology, the same was validated over a different area (parts of Saharanpur and Haridwar districts, India) during March 2005. Both test sites provided the variety of agricultural heterogeneity required for development and validation of the methodology for large-area soil moisture estimation. The proposed methodology offers an approach to incorporate the effects of surface roughness, crop cover, and soil texture in the soil moisture retrieval model from the space platform, without making any assumptions on the distributions of these parameters or without knowing the actual values of these parameters on ground. [J1176]

"Joint Transmitter and Receiver Polarization Optimization for Scattering Estimation in Clutter"

Controlling the polarization information in transmitted waveforms enables improving the performance of radar systems. We consider the design of optimal polarizations at both the radar transmitter and receiver for the estimation of target scattering embedded in clutter. The goal is to minimize the mean squared error of the scattering estimation subject to an average radar pulse power constraint. Under the condition that the target and clutter scattering covariance matrices are known a priori, we show that such a problem is equivalent to the optimal design of a radar sensing matrix that contains the polarization information. We formulate the optimal design as a nonlinear optimization problem and then recast it in a convex form and is thus efficiently solvable by semi-definite programming (SDP). We compare the sensing performance of the optimally selected polarization over conventional approaches. Our numerical results demonstrate that a significant amount of power gain is achieved in the target scattering estimation through such an optimal design. [J1177]

"Wireless Convergence (review of Fixed-Mobile Wireless Networks Convergence by J. Ghetie; 2008) [JBook/Software review]"

This book moves from the fundamentals of modern networks to projected developments and convergence of the various services. The book does a good job of bringing together the variety of networks and their advantages, disadvantages, standards, and potential for convergence. However, because it spends so much space on specific technologies, it will be out of date almost immediately. [J1178]

"The Utility of Spaceborne Radar to Render Flood Inundation Maps Based on Multialgorithm Ensembles"

On December 12, 2006, both the European Remote Sensing Satellite 2 and Environmental Satellite recorded a high-magnitude flood event on the River Dee in Wales (U.K.) only 28 min apart. This unique opportunity enables

the creation of a very rare but extremely useful observed data set for flood inundation studies. For flood management purposes, hydrodynamic models are often run after an event but with field data gauged during the event to approximate both flood area and depth. As an adequate aprioridefinition of model parameters is difficult, they tend to be run with multiple parameter sets to generate a likelihood of inundation map. However, as field observations of events are often very scarce, these output maps cannot be validated with field-observed probabilities. This paper illustrates how this unique set of spaceborne radar images can be used in combination with five widely used image processing techniques to generate an event-specific inundation map that expresses a degree of belief that a given pixel is possibly flooded. It is expected that the value of this multialgorithm ensemble-based map opens up new ways to evaluate the performance of hydrodynamic models, as it contains information which has, to the authors' knowledge, not previously been available. [J1179]

"New Sequence Design Criteria for Multipath Channels"

The merit factor (MF) introduced by Golay has long been accepted as the standard criterion to evaluate and designbinary sequences with good anti-multipath property in sonar, radar, and communication systems for its theoretical tightness and practical simplicity. In this paper, we first show that the MF is a biased anti-multipath performance-evaluation metric in theory and, more importantly, that it is nota pertinent sequence design criterion in practice for most binary sequences of practical interest. Then, we propose the weighted MF (WMF) based on a nonuniform weighting of the out-of-phase aperiodic autocorrelation function (ACF) that provides accurate measurement of self-generated interference for the constant-amplitude complex-valued sequences and the nonconstant modulus sequences. Based on the WMF, a list of ldquobadrdquo (of low MFs) binary sequences (lengths 33-95) with better anti-multipath performance than the ldquobestrdquo (known) binary sequences has been designed to verify its greater pertinence over the MF as a sequence design criterion for sonar, radar, and communication systems. Moreover, we extend the weighted correlation model of the WMF to code-division multiple-access (CDMA) systems and propose the weighted cross-correlation factor (WCF) to evaluate the sequence set's multiple-access interference (MAI) rejection property in the context of multipath propagation. Theoretical analysis corroborated by simulations confirms that the WCF provides greater practical pertinence and analytical tractability than the current standard criterion. [J1180]

"A Feasibility Assessment for Low-Cost InSAR Formation-Flying Microsatellites"

Multistatic interferometric synthetic aperture radar (InSAR) is a promising potential payload for a small satellite constellation. CanX-4 and CanX-5 are a pair of formation-flying nanosatellites launching in 2009; once formation flight has been demonstrated, a future multistatic InSAR constellation of low-cost microsatellites can exploit subcentimeter intersatellite baseline knowledge, with digital elevation map height errors on the order of 1 m in the flat-terrain case. This paper evaluates the feasibility of such a mission, using case studies of commonly proposed configurations: the Interferometric Cartwheel, the Cross-Track Pendulum, and the Cartwheel-Pendulum (Car-Pe) configuration. In each case, several SAR transmitters are considered: L-, C-, and X-band transmitters with parameters mirroring existing ldquolargerdquo satellite SAR missions, and a theoretical X-band microsatellite transmitter. The available interferometric baselines, ground coverage, and image resolutions are evaluated in each scenario. The X-band ldquomicrordquo transmitter is feasible, but the low transmit power severely limits the ground coverage. The X-band ldquolargerdquo transmitter provides the largest ground coverage and the highest resolution along with the X-band ldquomicrordquo option. The resolutions are wavelength dependent and remain relatively constant among the configurations. The operating areas of the pendulum demonstrate the largest degree of overlap, while the longer along-track baselines of the cartwheel result in a smaller overlap. Both two-receiver (pendulum and cartwheel) configurations demonstrate baseline characteristics that may be optimal for different applications, while the three-receiver Car-Pe demonstrates the advantages of both the pendulum and cartwheel. [J1181]

"AlGaN/GaN HFET reliability"

High-voltage AlGaN/GaN HFETs can produce high RF output power with nearly ideal power-added efficiency. But widespread adoption of these HFETs has been limited by a lack of acceptable reliability data for practical communications and radar applications. Device problems that have been observed include dc current and RF output power degradation as a function of time when the device is operating. Sudden and permanent degradation shifts in device performance have also been observed under certain operating conditions. Identified causes of the reliability problems include the quantum mechanical tunneling of electrons on the gate electrode to the surface of the semiconductor adjacent to the gate on the drain side, and a defect generation mechanism that occurs at a high, critical electric field. The gate leakage phenomenon described in this article produces electrons on the surface of the AlGaN layer adjacent to the gate electrode, and this creates a negative charge layer that partially depletes the conducting channel, thereby producing a degradation in dc current and RF output power. The gate leakage current is present when the device is biased and driven with an RF signal, and therefore the

charge accumulation increases as a function of operation time. The gate tunnel current is a very sensitive function of surface state density, particularly near the gate edge, and of the magnitude of the electric field at this location. In addition, at a critical magnitude of the electric field defects in the AlGaN layer are created due to mechanical stress on the crystal structure, and these defects act as charge trapping centers. This mechanism is not well understood at this time and is currently the subject of research and investigation. Parameters that affect reliability are a function of device design and surface processing. Improvements in device reliability have been achieved through design modifications to produce improved surface passivation layers that reduce the gate and surf- ace leakage currents and further modifications to reduce the magnitude of the electric field internal to the device. Continuing reliability study is required to fully elucidate the link between observed degradation behavior and physical failure mechanisms in a statistically significant manner. [J1182]

"Pushing the boundaries"

This article's objective is to report on the recent technological activities in microwave photonics that are currently being carried out in Europe, mainly within the integrated European IPHOBAC project, though many other projects in microwave photonics are being carried out in other parts of the world, especially in Japan, various Asian countries, and North America. The IPHOBAC project is application-driven; an overview of its technical objectives is presented. For each application field (communications, radar/sensing, and instrumentation), at least one specific system demonstration has been planned. This is done to demonstrate the capabilities and advantages of the developed microwave photonic technologies in systems. This approach also provides clear guidance for defining the specifications of the components and modules to be developed. [J1183]

"Integration of InSAR Time-Series Analysis and Water-Vapor Correction for Mapping Postseismic Motion After the 2003 Bam (Iran) Earthquake"

Atmospheric water-vapor effects represent a major limitation of interferometric synthetic aperture radar (InSAR) techniques, including InSAR time-series (TS) approaches (e.g., persistent or permanent scatterers and small-baseline subset). For the first time, this paper demonstrates the use of InSAR TS with precipitable water-vapor (InSAR TS + PWV) correction model for deformation mapping. We use MEdium Resolution Imaging Spectrometer (MERIS) near-infrafred (NIR) water-vapor data for InSAR atmospheric correction when they are available. For the dates when the NIR data are blocked by clouds, an atmospheric phase screen (APS) model has been developed to estimate atmospheric effects using partially water-vapor-corrected interferograms. Cross validation reveals that the estimated APS agreed with MERIS-derived line-of-sight path delays with a small standard deviation (0.3-0.5 cm) and a high correlation coefficient (0.84-0.98). This paper shows that a better TS of postseismic motion after the 2003 Bam (Iran) earthquake is achievable after reduction of water-vapor effects using the InSAR TS + PWV technique with coincident MERIS NIR water-vapor data. [J1184]

"SAR image despeckling via bilateral filtering"

Bilateral filtering (BF) can realise both smoothing images and preserving edges, whereas its filtering results are always influenced since its two parameters are difficult to configure to the optimum. In this reported work, the application of BF is extended to synthetic aperture radar (SAR) image despeckling, and the despeckling evaluation indexes, including the equivalent number of looks and the edge save index, are used to estimate the parameters. After BF with estimated parameters imposed on a normalised SAR image, further processing can achieve both despeckling and edge preservation simultaneously. Experimental results show that the visual quality and evaluation indexes of the proposed algorithm outperform the classical Lee filtering. [J1185]

"Blumlein Configuration for High-Repetition-Rate Pulse Generation of Variable Duration and Polarity Using Synchronized Switch Control"

Blumlein generators are used in different applications such as radars, lasers, and also recently in various biomedical studies, where the effects of high-voltage nanosecond pulses on biological cells are evaluated. In these studies, it was demonstrated that by applying high-voltage nanosecond pulses to cells, plasma membrane and cell organelles are permeabilized. As suggested in a recent publication, the repetition rate and polarity of nanosecond high-voltage pulses could have an important effect on the electropermeabilization process, and consequently, on the observed phenomena. Therefore, we designed a new Blumlein configuration that enables a higher repetition rate of variable duration of either bipolar or unipolar high-voltage pulses. We achieved a maximal pulse repetition rate of 1.1 MHz. However, theoretically, this rate could be even higher. We labeled endocytotic vesicles with lucifer yellow and added propidium iodide to a cell suspension for testing the cell plasma membrane integrity, so we were able to observe the permeabilization of endocytotic vesicles and the cell plasma membrane at the same time. The new design of pulse generator was built, verified, and also tested in experiments. The resulting flexibility and variability allow further in vitro experiments to determine the importance

of the pulse repetition rate and pulse polarity on membrane permeabilization-both of the cell plasma membrane as well as of cell organelle membranes. [J1186]

"Wavelet-Based Compression With ROI Coding Support for Mobile Access to DICOM Images Over Heterogeneous Radio Networks"

Most of the commercial medical image viewers do not provide scalability in image compression and/or region of interest (ROI) encoding/decoding. Furthermore, these viewers do not take into consideration the special requirements and needs of a heterogeneous radio setting that is constituted by different access technologies [e.g., general packet radio services (GPRS)/ universal mobile telecommunications system (UMTS), wireless local area network (WLAN), and digital video broadcasting (DVB-H)]. This paper discusses a medical application that contains a viewer for digital imaging and communications in medicine (DICOM) images as a core module. The proposed application enables scalable wavelet-based compression, retrieval, and decompression of DICOM medical images and also supports ROI coding/decoding. Furthermore, the presented application is appropriate for use by mobile devices activating in heterogeneous radio settings. In this context, performance issues regarding the usage of the proposed application in the case of a prototype heterogeneous system setup are also discussed. [J1187]

"Road-Condition Recognition Using 24-GHz Automotive Radar"

This paper studies 24-GHz automotive radar technology for detecting low-friction spots caused by water, ice, or snow on asphalt. The backscattering properties of asphalt in different conditions are studied in both laboratory and field experiments. In addition, the effect of water on the backscattering properties of asphalt is studied with a surface scattering model. The results suggest that low-friction spots could be detected with a radar by comparing backscattered signals at different polarizations. The requirements for the radar are considered, and a 24-GHz radar for road-condition recognition is found to be feasible. [J1188]

"Improved Correction of Beam Mismatch of the Precipitation Radar After Orbit Boost of the TRMM Satellite"

One effort in developing the Tropical Rainfall Measuring Mission (TRMM) precipitation radar (PR) data processing algorithm is to correct the PR received power for mismatched-beam data after the orbit is boosted. The current standard algorithm employs a beam-mismatch correction algorithm based on the rain-echo radar equation (Takahashi's method). However, there remains a need for improving the estimated power of the mismatched-pulse echo returned from the Earth's surface and weak rain because the echo is represented with the surface-echo radar equation and the noise-power level. The error in Takahashi's method causes a negative bias (around 1 dB) in the PR received power near the main lobe clutter. This paper formulates an improved estimate of the mismatched pulse based on the rain-echo radar equation and the surface-echo radar equation for a flat-Earth surface. The improved estimate is then evaluated numerically and experimentally with the actual data obtained by TRMM/PR for observations over the ocean. The consistency of TRMM/PR data sets between preboost and postboost was improved by eliminating the negative bias (around 1 dB) in the PR received power. The mean rain rate near the surface-echo range increases by 10%, and the angle-bin asymmetry of the mean rainfall rate, which is present in the postboost data corrected by Takahashi's method, is resolved. [J1189]

"One- and Two-Stage Tunable Receivers*"

We propose and assess a CFAR detector that can adjust its ldquodirectivityrdquo through a real scalar parameter. It relies on the usual assumption that a set of homogeneous training data is available and encompasses as special cases the well-known Kelly's GLRT and the recently introduced W-ABORT detector. More important, it can be tuned in order to control the level to which sidelobe signals are rejected. Such functionality is particularly important to contain the number of false alarms in presence of mismatched signals. We also consider a parametric detector which resorts to a diagonally loaded sample covariance matrix commonly adopted to take advantage of the presence of strong interferers. The performance assessment of such detector has shown that it can significantly outperform Kelly's GLRT in terms of prediction probabilities for matched signals and in terms of selectivity, but it is not strictly CFAR. We also propose to use the CFAR parametric detector as second stage of a two-stage tunable detector and show that such a two-stage detector can outperform already proposed tunable receivers in terms of selectivity. The analysis of the detectors is conducted assuming a homogeneous Gaussian environment; with reference to this scenario and to the CFAR detectors we derive analytical expressions for the probability of false alarm and the probability of detection for both matched and mismatched signals. [J1190]

"The EnviSat RA-2 Instrument Design and Tracking Performance"

The EnviSat satellite embarks an innovative radar altimeter, the RA-2 which represents a new generation of radar altimeters compared to previous instruments such as the European Remote Sensing Satellite (ERS) altimeters and The Ocean Topography Experiment/Poseidon. This is due to its integration of many new features. In particular, the RA-2 is the first satellite altimeter to incorporate autonomous resolution selection and a model-free tracker. The behavior of the instrument in orbit is controlled by onboard algorithms which determine the instrument logic, and a list of onboard parameters which control when switches in resolution occur. This logic and the choice of these parameters have a strong influence on the tracking performance. This paper describes the operation of the RA-2 onboard tracker and the resolution selection logic. We provide a detailed description of the algorithm and its configuration parameters after optimization during the EnviSat Commissioning Phase. Finally, we show the tracking performance, in particular compared to the ones of the ERS-2 altimeter, over different types of surfaces. [J1191]

"Three-dimensional automatic mesh generation for hybrid electromagnetic simulations"

Hybrid mesh generation is required for finite-difference time-domain/finite-element time-domain (FDTD/FETD) hybrid simulations. A combined approach is presented to automatically generate Cartesian/tetrahedral hybrid meshes for open and closed structures. This approach first generates a buffer zone that surrounds a target with specified tightness. The advancing-front technique with ldquosweep-and-retryrdquo is subsequently applied to generate an initial tetrahedral mesh that fills the buffer zone. Finally, the tetrahedral mesh undergoes a combined quality improvement procedure. Due to the low profile of the resulting tetrahedral mesh, the sparse Cholesky decomposition can be applied effectively to solve the resulting FETD matrix. Several examples are provided to demonstrate the main features and the performance of the proposed automatic mesh-generation method. [J1192]

"Combining magnetic resonance imaging and ultrawideband radar: A new concept for multimodal biomedical imaging"

Due to the recent advances in ultrawideband (UWB) radar technologies, there has been widespread interest in the medical applications of this technology. We propose the multimodal combination of magnetic resonance (MR) and UWB radar for improved functional diagnosis and imaging. A demonstrator was established to prove the feasibility of the simultaneous acquisition of physiological events by magnetic resonance imaging and UWB radar. Furthermore, first in vivo experiments have been carried out, utilizing this new approach. Correlating the reconstructed UWB signals with physiological signatures acquired by simultaneous MR measurements, representing respiratory and myocardial displacements, gave encouraging results which can be improved by optimization of the MR data acquisition technique or the use of UWB antenna arrays to localize the motion in a focused area. [J1193]

"Performance of Discrete-Fourier-Transform-Based Velocity Estimators for a Wind-Sensing Coherent Doppler Lidar System in the Kolmogorov Turbulence Regime"

The performance of discrete-Fourier-transform (DFT)-based velocity estimators for wind-sensing coherent Doppler lidar systems in the Kolmogorov turbulence regime is summarized using Monte Carlo simulations. Furthermore, a signal model, a simulation procedure, velocity estimators, and simulation conditions are explained. The relationships between signal-to-noise ratio, line-of-sight velocity estimation precision, and signal detection probability are simulated and summarized. In addition to the basic DFT estimator, signal matching estimators which utilize DFT are studied. The performances in the Kolmogorov turbulence regime and those in the Gaussian autocovariance signal model are compared. The performances are compared for wavelength regions of 1.5, 2, and 10 mum. [J1194]

"Noninvasive probing of the human body with electromagnetic pulses: Modeling of the signal path"

The biomedical applications of ultrawideband (UWB) radar promise a very important means to remotely monitor physiological signatures such as myocardial deformation and respiration. Accurate numerical and analytical techniques to predict the propagation of UWB signals in biological tissue are of great interests to researchers as an aid in developing signal processing algorithms. We propose applying an analytic transmit/receive signal path model considering the antennas, the human body, and the signal processing part of the UWB unit. Furthermore, the frequency dependency of the different biological tissues' dielectric properties and the individual continuous motion of intrathoracic tissue layers are incorporated. [J1195]

"Passive Localization of Near-Field Sources Using Cumulant"

Passive source localization is one of the issues in array signal processing fields. When some source lies in the

Fresnel region of the array (i.e., near-field), the wavefront of the source must be characterized by both the direction-of-arrival (DOA) and range. To localize near-field sources, some classical far-field source localization methods are modified to estimate DOA and range at the costs of array aperture, which contains two hands: (i) quarter- wavelength constraint is imposed on the intersensor spacing and (ii) fewer sources in the near-field case are localized from an array of given sensor number than those of the far-field case. In addition, it is necessary to match two separately estimated electric angles (function of DOA and range) of multiple near-field sources, i.e., encountering parameter match problem. To solve these problems, this paper develops a new cumulant-based algorithm (CBA). The key points of this paper are: (i) based on the rank-reduction idea, the nonlinear optimization problem of two-dimensional parameters is decoupled to avoid both pairing parameters and two-dimensional search; (ii) unlike some classical near-field source localization algorithms, the quarter-wavelength element spacing constraint is not required in the proposed algorithm. Simulation results are presented to validate the performance of the proposed method. [J1196]

"Doppler Shift Mitigating Algorithm for Quadrature Phase Delay Estimator"

A method is proposed to estimate the phase delays of the sinusoid components in a noisy multifrequency signal using quadrature phase delay estimator (QDE). Linear regression is applied to mitigate the bias caused by the Doppler shift between the input and the reference signal. The variance formula of the estimator is derived. Simulation results showing the effectiveness of the algorithm are presented. [J1197]

"The Design, Fabrication and Test Results of a 1.6 THz Superconducting Hot Electron Bolometer Mixer on SOI"

Interest in THz technology is growing, with projects such as the Atacama large millimeter array (ALMA) astronomical observatory, biohazard remote detection, high frequency radar and other detection systems. This paper presents the design, fabrication and test results of a 1.6 THz superconducting phonon-cooled NbN hot electron bolometer. Elements of the mixer design, including simulation results and S-parameters, are presented. A novel fabrication process, the suspended sidewall nano patterned stencil (SSNaPS) procedure, along with unique thin silicon backside processing, is used to create these THz mixers. For the phonon-cooled mixer, a receiver noise temperature of 3474 K and a mixer noise temperature of 613 K were obtained. DC characterization and RF test results are discussed. [J1198]

"Aerosol Lidar Intercomparison in the Framework of SPALINET-The Spanish Lidar Network: Methodology and Results"

A group of eight Spanish lidars was formed in order to extend the European Aerosol Research Lidar Network-Advanced Sustainable Observation System (EARLINET-ASOS) project. This study presents intercomparisons at the hardware and software levels. Results of the system intercomparisons are based on range-square-corrected signals in cases where the lidars viewed the same atmospheres. Comparisons were also made for aerosol backscatter coefficients at 1064 nm (2 systems) and 532 nm (all systems), and for extinction coefficients at 532 nm (2 systems). In total, three field campaigns were carried out between 2006 and 2007. Comparisons were limited to the highest layer found before the free troposphere, i.e., either the atmospheric boundary layer or the aerosol layer just above it. Some groups did not pass the quality assurance criterion on the first attempt. Following modification and improvement to these systems, all systems met the quality criterion. The backscatter algorithm intercomparison consisted of processing lidar signal profiles simulated for two types of atmospheric conditions. Three stages with increasing knowledge of the input parameters were considered. The results showed that all algorithms work well when all inputs are known. They also showed the necessity to perform, when possible, additional measurements to attain better estimation of the lidar ratio, which is the most critical unknown in the elastic lidar inversion. [J1199]

"Institutional Listings"

{no data available} [J1200]

"Hybrid GPU-Based Single- and Double-Bounce SAR Simulation"

In this paper, a new hybrid graphics-processing-unit (GPU)-based real-time synthetic aperture radar (SAR) simulation system is presented. Previous real-time SAR simulators only supported single-bounce simulation in real time. The new hybrid system uses the rasterization approach for real-time single-bounce simulation and a new image-based GPU ray-tracing approach for monostatic SAR double-bounce simulation. This approach provides fast simulation results even while simulating complex and extended scenes. The simulation results are compared to a high-resolution airborne SAR image, and the limitations of the approach are discussed. [J1201]

"Modeling and Simulation of SAR Image Texture"

The characteristics of synthetic aperture radar (SAR) image texture may be related to the properties of underlying elemental scene scatterers through established models based on the properties of a backscattering coefficient (in this paper, we use and unnormalized coefficient s) of these scatterers. In this paper, we generate raw SAR data by simulating the statistical characteristics of elemental scene scatterers such as the order of the gamma distribution, the form and length of their spatial correlation, and their spatial density. This simulation is carried out using a SAR signal simulation system called cSAR. We describe a particular set of methods to simulate image texture used in cSAR, and provide a detailed analysis of simulated sand of the speckle and texture characteristics of simulated images. We found that the distribution of swas strongly affected by the order, density, and correlation length of the underlying scatterers. We found that the simulated SAR images were consistently K-distributed as expected. The estimated image order was a strong function of the scattering properties and that the estimated image order is a relatively weak descriptor of image texture when used on its own. The correspondence between the observed image autocorrelation function (ACF) and the theoretical models of Oliver is excellent, and we could estimate the scatterer correlation length by fitting the Oliver model to the observed ACF. We combined the estimated image order and correlation length and found potential for using these two image texture descriptors in classification and segmentation algorithms. [J1202]

"Demonstration of a Network of Simultaneously Operating Digital Noise Radars [JMeasurements Corner]"

Search and rescue following a natural disaster is a difficult problem, exacerbated by the cluttered environment obscuring human victims. It is well known that UHF radar-frequency radiation can penetrate the types of materials typically found in these situations with relatively little loss. This paper discusses the development of a network of digital noise radars, designed to operate in that frequency range to locate and track human movement through walls and rubble. Each individual noise radar works by cross correlating the received signal with a replica of the transmit signal. A high correlation indicates the range to the target. This noise radar design makes use of the software radar concept by converting the analog transmitted and received signals to digital signals. With the signals in digital form, the cross-correlation process can be accomplished in software. A network of three digital noise radars was developed. The three radars operated simultaneously in the same frequency range, without interference, to triangulate the (x, y) position of a target within a room. The results showed that the network of radars was capable of locating and tracking a human through an obscuring wall. [J1203]

"Measurements and Calibrations of Larger Squat Cylinders"

RCS measurements of two larger squat cylinders (with diameters of 18 in and 15 in) have been studied. Numerical extrapolation from the best available MoM simulation was used to generate the finer oscillations (les 0.1 dB) in RCS-PO at higher frequencies. Although the uncertainties at 0.4 dB would obscure the opportunity for a comparison at this time, a smoothly silver-painted surface did yield error bars at 0.2 dB for the Ku band. [J1204]

"2008 IEEE Radar Conference-Rome, Italy 26-30 May 2008"

{no data available} [J1205]

"Limiting Case of a Lack of Rich Scattering Environment for MIMO Radar Diversity"

A radar system with Mtransmit and Nreceive antennas which are widely separated is employed to detect the presence of a target at a given point in space. This target is assumed to be composed of Qpoint scatterers which are closely spaced with respect to the waveforms transmitted by the radar system. The diversity gain for radar systems employing optimum processing (likelihood ratio tests) for detecting the presence of these targets is shown to be less than or equal to min(Q,MN). [J1206]

"Relationship Between PALSAR Backscatter and Surface-Roughness Parameters From Iron Laterites in CarajЂs, Amazon Region"

The objective of this investigation was to evaluate the influence of micro- and macrotopography on PALSAR fine-beam dual backscattering in the characterization of iron laterites in Carajas Province, Amazon Region. The moderate linear correlation between sigma0and surface roughness indicated that, only for L-HH polarization, sigma0was modulated by the morphology of the geological surfaces. [J1207]

"Assessment of Atmospheric Propagation Effects in SAR Images"

TerraSAR-X, the first civil German synthetic aperture radar (SAR) satellite, was successfully launched on June 15, 2007. After 4.5 days, the first processed image was obtained. The overall quality of the image was outstanding; however, suspicious features could be identified which showed precipitation-related signatures. These rain-cell signatures are thoroughly investigated, and the physical background of the related propagation effects is provided. In addition, rain-cell signatures from former missions like SIR-C/X and the Shuttle Radar Topography Mission are provided for comparison. During the commissioning phase of TerraSAR-X, a total of 12 000 scenes were investigated for potential propagation effects, and about 100 scenes revealed atmospheric effects to a visible extent. Some of the particularly interesting events were selected and are discussed in greater detail. An interesting case of data acquisition over New York will be presented, which shows typical rain-cell signatures, and the SAR image will be compared with weather-radar data acquired nearly simultaneously (within the same minute). By comparing the images, it can be clearly seen that reflectivities in the weather-radar image of 50 dBZ may cause visible artifacts in SAR images. Furthermore, in this paper, we discuss the influence of the atmosphere (troposphere) on the external calibration of TerraSAR-X. By acquiring simultaneous weather-radar data over the test site and the SAR acquisition, it was possible to flag affected SAR images and to exclude them from the procedure to derive the absolute calibration constant. Thus, it was possible to decrease the 1 sigma uncertainty of the absolute calibration factor by 0.15 dB. [J1208]

"A Change Detection Algorithm for Retrieving High-Resolution Soil Moisture From SMAP Radar and Radiometer Observations"

A change detection algorithm has been developed in order to obtain high-resolution soil moisture estimates from future Soil Moisture Active and Passive (SMAP) L-band radar and radiometer observations. The approach combines the relatively noisy 3-km radar backscatter coefficients and the more accurate 36-km radiometer brightness temperature into an optimal 10-km product. In preparation for the SMAP mission, an observation system simulation experiment (OSSE) and field experimental campaigns using the Passive and Active L- and S-band Airborne Sensor (PALS) have been conducted. We use the PALS airborne observations and OSSE data to test the algorithm and develop an error budget table. When applied to four-month OSSE data, the change detection method is shown to perform better than direct inversion of the radiometer brightness temperatures alone, improving the root mean square error by 2% volumetric soil moisture content. The main assumptions of the algorithm are verified using PALS data from the soil moisture experiments held during June-July 2002 (Soil Moisture Experiment 2002) in Iowa. The algorithm error budget is estimated and shown to meet SMAP science requirements. [J1209]

"Operational Large-Area Forest Monitoring in Siberia Using ALOS PALSAR Summer Intensities and Winter Coherence"

Focusing on Siberia, the feasibility of using Advanced Land Observing Satellite Phased Arrayed L-band Synthetic Aperture Radar (PALSAR) summer-intensity and winter-coherence images for large-area forest monitoring was investigated. Fine beam dual horizontal/horizontal and horizontal/vertical (polarization) intensity strip images were acquired during the summer of 2007. The processing consisted of radiometric calibration, orthorectification, and topographic normalization. The coherence was estimated from interferometric pairs with 46-day repeat-pass intervals. The pairs were acquired during the winters of 2006/2007 and 2007/2008. During both winters, suitable weather conditions that allow for low temporal decorrelation had been reported. By using PALSAR intensities and winter-coherence data, areas of forest and nonforest were separated. By combining both data types, a minimal overlap of the class signatures was observed, even though the analysis was conducted at the pixel level and no speckle filter was applied. The study concludes that the operational delineation of forest cover using PALSAR data is feasible. By applying a segmentation-based classification, an accuracy of 93% was obtained. [J1210]

"Forest Biophysical Parameter Estimation Using L- and P-Band Polarimetric SAR Data"

L- and P-band airborne polarimetric synthetic aperture radar (SAR) data acquired by the RAMSES system over different height maritime pine (Pinus Pinaster Ait.) stands of the Nezer forest (Landes, France) have been evaluated for forest biophysical parameter estimation. A pseudolinear correlation has been brought to evidence at P-band between polarimetric anisotropy and mean tree height, which is also linked to other biophysical parameters in the Nezer forest, meaning that SAR polarimetry constitutes a promising tool for forest parameter retrieval at low frequency. The spatial conditions have been evaluated through the quantification of the impact of signal-to-noise ratio diminution and resolution degradation on the forest height inversion. It has been shown that the inversion accuracy remains acceptable for N Esigma0, representing the noise level of the SAR image, which is lower than -15 dB, and for spatial resolution increasing up to 15 m. [J1211]

"Seasonal variation of site diversity performance"

A study of the seasonal performance of site diversity (SD) using four years of rain radar measurements in South England is presented. Detailed analyses of site diversity gain as well as the spatial correlation of rain attenuation at pairs of sites of various separation distances and baseline orientations reveal significant seasonal dependence, a much greater efficacy of SD for fade mitigation in the summer and a larger sensitivity of the technique to baseline orientation in non-summer seasons. [J1212]

"Dual-polarised dielectric resonator antenna with high isolation and low cross-polarisation"

A novel, dual-polarised dielectric resonator antenna with high-isolation and low cross-polarisation is presented using a hybrid feeding technique. Port isolation of 35.9 dB and a cross-polarisation level of -34 dB are measured. The impedance bandwidth of return loss less than -10 dB is 440 MHz (7.9%) with a centre frequency of 5.7 GHz. Since its feeding mechanism is symmetric, a symmetric radiation pattern is also achieved. It is suitable for the application of synthesis aperture radar and some wireless systems. [J1213]

"CPW-Fed Quasi-Magnetic Printed Antenna for Ultra-Wideband Applications"

An optimized coplanar waveguide fed quasimagnetic printed antenna for ultra wideband applications is described. A parameter study, motivated by a design procedure, allowed a substantial increase in the return-loss operational bandwidth. The numerically predicted performance was validated by means of physical measurements of fabricated samples. The measured radiation patterns of the antenna demonstrated its adequate radiation characteristics. The feed radiation was also investigated by means of physical measurements. [J1214]

"Polyphase Pulse Compression Codes with Optimal Peak and Integrated Sidelobes"

Nearly optimal or globally optimal integrated sidelobe level (ISL) polyphase codes are found for lengths 46 through 80 by using a stochastic optimization technique. Polyphase Barker codes are found for lengths 64 to 70, and 72, 76, and 77 using constrained optimization starting at optimal-ISL codes. [J1215]

"Differential Evolution Using a Neighborhood-Based Mutation Operator"

Differential evolution (DE) is well known as a simple and efficient scheme for global optimization over continuous spaces. It has reportedly outperformed a few evolutionary algorithms (EAs) and other search heuristics like the particle swarm optimization (PSO) when tested over both benchmark and real-world problems. DE, however, is not completely free from the problems of slow and/or premature convergence. This paper describes a family of improved variants of the DE/target-to-best/1/bin scheme, which utilizes the concept of the neighborhood of each population member. The idea of small neighborhoods, defined over the index-graph of parameter vectors, draws inspiration from the community of the PSO algorithms. The proposed schemes balance the exploration and exploitation abilities of DE without imposing serious additional burdens in terms of function evaluations. They are shown to be statistically significantly better than or at least comparable to several existing DE variants as well as a few other significant evolutionary computing techniques over a test suite of 24 benchmark functions. The paper also investigates the applications of the new DE variants to two real-life problems concerning parameter estimation for frequency modulated sound waves and spread spectrum radar poly-phase code design. [J1216]

"Mitigating Range Ambiguity in High PRF Radar using Inter-Pulse Binary Coding"

The paper proposes a way to increase the energy within a coherent processing interval (CPI) using more pulses instead of longer pulses. Long coded pulses result in masking targets at close range and poor Doppler tolerance. Increasing the number of pulses implies high pulse repetition frequency (PRF), which suffers from range ambiguity and target folding. These drawbacks of a high PRF can be mitigated by inter-pulse coding. The approach suggested here should be attractive for close and mid range applications of radar, ground penetrating radar, ultrasound imaging, and more. [J1217]

"A Multistage Processing Algorithm for Disturbance Removal and Target Detection in Passive Bistatic Radar"

The paper examines the problem of cancellation of direct signal, multipath and clutter echoes in passive bistatic radar (PBR). This problem is exacerbated as the transmitted waveform is not under control of the radar designer and the sidelobes of the ambiguity function can mask targets including those displaced in either (or both) range and Doppler from the disturbance. A novel multistage approach is developed for disturbance cancellation and target detection based on projections of the received signal in a subspace orthogonal to both the disturbance and previously detected targets. The resulting algorithm is shown to be effective against typical simulated

scenarios with a limited number of stages, and a version with computational savings is also introduced. Finally its effectiveness is demonstrated with the application to real data acquired with an experimental VHF PBR system. [J1218]

"Estimating Moving Targets Behind Reinforced Walls Using Radar"

We consider the estimation of moving targets located behind concrete walls reinforced with metallic bars, using radar measurements. The periodic structure of the rebar severely attenuates and distorts transmitted waveforms, which produces defocused images with ghost target estimates. We apply beamforming to estimate permittivity and thickness of the wall and number and position of the targets. The proposed solution is based on accurate physical models calculated using the method of moments. We show that the estimation is significantly improved by modeling the waveform distortion due to the bars. The resulting images are focused and clearly represent the contours of the targets. The algorithm is robust to the ambiguities in bar parameter values. In addition, the minimal necessary SNR is lower compared with the case in which the influence of the bars on the signal shape is ignored. [J1219]

"Circularity and Gaussianity Detection Using the Complex Generalized Gaussian Distribution"

Knowing the statistical properties of a complex-valued signal is important in many signal processing applications by providing the necessary information for choosing the appropriate algorithm. In this paper, we provide generalized likelihood ratio tests (GLRT), based on the complex generalized Gaussian distribution (CGGD), for detecting two important signal properties: 1) the circularity of a complex random variable, not constrained to the Gaussian case and 2) whether a complex random variable is complex Gaussian. These tests can be combined to statistically determine if a complex random variable is, the often assumed, circular Gaussian. Simulations are used to quantify the performance of the detectors followed by application to communication signals and actual radar data. [J1220]

"BRDF Analysis of Savanna Vegetation and Salt-Pan Samples"

In this paper, laboratory-based bidirectional reflectance distribution function (BRDF) analysis of vegetation leaves, soil, and leaf-litter samples is presented. The leaf litter and soil samples, numbered 1 and 2, were obtained from a site located in the savanna biome of South Africa (Skukuza: 25.0deg S, 31.5deg E). A third soil sample, number 3, was obtained from Etosha Pan, Namibia (19.20deg S, 15.93deg E, altitude of 1100 m). In addition, BRDF of local fresh and dry leaves from tulip polar tree (Liriodendron tulipifera) and black locust tree (Robinia pseudoacacia) were studied. It is shown how the BRDF depends on the incident and scatter angles, sample size (i.e., crushed versus whole leaf), soil samples fraction size, sample status (i.e., fresh versus dry leaves), vegetation species (i.e., poplar versus locust), and the vegetation's biochemical composition. As a demonstration of the application of the results of this paper, airborne BRDF measurements acquired with NASA's Cloud Absorption Radiometer over the same general site where the soil and leaf-litter samples were obtained are compared to the laboratory results. Good agreement between laboratory and airborne-measured BRDF is reported. [J1221]

"Scale-Dependent Surface Roughness Behavior and Its Impact on Empirical Models for Radar Backscatter"

One goal of radar remote sensing is the extraction of terrain statistics and surface dielectric properties from backscatter data for some range of wavelengths, incidence angles, and polarizations. This paper addresses empirical approaches used to estimate terrain properties from radar data over a wider range of roughness than permitted by analytical models. Many empirical models assume, at least implicitly, that roughness parameters like rms height or correlation length are independent of the horizontal length scale over which they are measured, in contrast to recent surveys of natural terrain, which show that self-affine, or power-law scaling, between horizontal scale and roughness statistics is very common. The rms slope at the horizontal scale of the illuminating wavelength s(lambda) is directly related to the variogram or structure function of a self-affine surface, can be readily obtained from field-measured topography, and, when used in an empirical model, avoids the need for arbitrary wavelength-dependent terms. To facilitate comparison with earlier approaches, an expression that links the rms height at some profile length with the rms (Allan) deviation at an equivalent horizontal sampling interval is obtained from numerical simulations. An empirical model for polarimetric scattering as a function of s(lambda) at 35deg-60deg incidence from smooth to rugged lava surfaces is derived and compared with earlier models for backscatter from modestly rough soil surfaces. The asymptotic behavior of polarization ratios for the lava flows suggests that the depolarization of linear-polarized illuminating signals occurs as a first-order process, likely through single scattering by rock edges or other discontinuities, rather than as the solely multiple-scattering effect predicted by some analytical models. Efforts to fully understand radar scattering from geological surfaces

need to incorporate wavelength-scale roughness, perhaps through computational simulat--ions. [J1222]

"Doppler Compensation & Single Pulse Imaging using Adaptive Pulse Compression"

The effects of target Doppler are addressed in relation to adaptive receive processing for radar pulse compression. To correct for Doppler-induced filter mismatch over a single pulse, the Doppler-compensated adaptive pulse compression (DC-APC) algorithm is presented whereby the respective Doppler shifts for large target returns are jointly estimated with the illuminated range profile and subsequently incorporated into the original APC adaptive receive filter formulation. As a result, the Doppler-mismatch-induced range sidelobes can be suppressed thereby regaining a significant portion of the sensitivity improvement that is possible when applying adaptive pulse compression (APC) without the existence of significant Doppler mismatch. In contrast, instead of compensating for Doppler mismatch, the single pulse imaging (SPI) algorithm generalizes the APC formulation for a bank of Doppler-shifted matched filters thereby producing a sidelobe-suppressed range-Doppler image from the return signal of a single radar pulse which is applicable for targets with substantial variation in Doppler. Both techniques are based on the recently proposed APC algorithm and its generalization, the multistatic adaptive pulse compression (MAPC) algorithm, which have been shown to be effective for the suppression of pulse compression range sidelobes thus dramatically increasing the sensitivity of pulse compression radar. [J1223]

"Power converters and amplifiers (review of "Pulse-Width Modulated DC-DC Power Converters" by Kazimierczuk, M.K.; 2008) [JBook News]"

This book is a comprehensive textbook in the areas of electrical, electronics, and telecommunications engineering. It consists of 17 chapters and two appendices. Some of the topics covered include: buck PWM DC-DC converters; boost PWM DC-DC converters; buck-boost-PWM DC-DC converters; half-bridge and full-bridge converters; push-pull PWM DC-DC converters; open-loop small-signal characteristics of boost converters for CCM; current-mode control of boost converters; silicon and silicon carbide power diodes; and soft-switching DC-DC converters. Appendix A is an introduction to SPICE and Appendix B provides an introduction to MATLAB. Answers to problems and the index are also included at the end of the book. The book is recommended for senior undergraduate and graduate students but also for practicing engineers working with switch-mode power supplies, within applications such as computers, telecommunications, industrial electronic systems, automobile electronics, medical equipment, radars, and aerospace power technology. [J1224]

"Power converters and amplifiers (review of "RF Power Amplifiers" by Kazimierczuk, M.K.; 2008) [JBook News]"

This is a comprehensive textbook covering the fundamentals of RF power amplifiers and their range of applications in radio and TV broadcasting, wireless communications, and radars. It presents accessible coverage of the complex principles of operation of RF power amplifiers and radio power systems. It introduces the fundamental design techniques and procedures for practitioners for RF power amplifiers. All the chapters contain examples and design procedures throughout, with review questions, problems, and references at the end of each chapter. A solutions manual is available for instructors. This textbook is helpful for students as well as for practicing engineers working with RF power amplifiers in such application areas as computers, telecommunications, industrial electronic systems, automotive electronics, radars, medical equipment, and aerospace power technology. [J1225]

"Designing Unimodular Sequence Sets With Good Correlations-Including an Application to MIMO Radar"

A multiple-input multiple-output (MIMO) radar system that transmits orthogonal waveforms via its antennas can achieve a greatly increased virtual aperture compared with its phased-array counterpart. This increased virtual aperture enables many of the MIMO radar advantages, including enhanced parameter identifiability and improved resolution. Practical radar requirements such as unit peak-to-average power ratio and range compression dictate that we use MIMO radar waveforms that have constant modulus and good auto- and cross-correlation properties. We present in this paper new computationally efficient cyclic algorithms for MIMO radar waveform synthesis. These algorithms can be used for the design of unimodular MIMO sequences that have very low auto- and cross-correlation sidelobes in a specified lag interval, and of very long sequences that could hardly be handled by other algorithms previously suggested in the literature. A number of examples are provided to demonstrate the performances of the new waveform synthesis algorithms. [J1226]

"Comments on "Modified Hough Transform for Searching Radar Detection""

This correspondence points out an important error of calculating the detection probability in a recent paper by Jiankui et al. (2008). The authors make a mistake in the analysis of the distribution of the detector statistic. Therefore, the calculation of the detection probability is wrong. In this correspondence, a new detection probability is calculated. [J1227]

"Adaptive Radar Detection in Doubly Nonstationary Autoregressive Doppler Spread Clutter"

The problem of adaptive radar detection in clutter which is nonstationary both in slow and fast time is addressed. Nonstationarity within a coherent processing interval (CPI) often precludes target detection because of the masking induced by Doppler spreading of the clutter. Across range bins (i.e., fast time), nonstationarity severely limits the amount of training data available to estimate the noise covariance matrix required for adaptive detection. Such difficult clutter conditions are not uncommon in complex multipath propagation conditions where path lengths can change abruptly in dynamic scenarios. To mitigate nonstationary Doppler spread clutter, an approximation to the generalized likelihood ratio test (GLRT) detector is presented wherein the CPI from the hypothesized target range is used for both clutter estimation and target detection. To overcome the lack of training data, a modified time-varying autoregressive (TVAR) model is assumed for the clutter return. In particular, maximum likelihood (ML) estimates of the TVAR parameters, computed from a single snapshot of data, are used in a GLRT for detecting stationary targets in possibly abruptly nonstationary clutter. The GLRT is compared with three alternative methods including a conceptually simpler ad hoc approach based on extrapolation of quasi-stationary data segments. Detection performance is assessed using simulated targets in both synthetically-generated and real radar clutter. Results suggest the proposed GLRT with TVAR clutter modeling can provide between 5-8 dB improvement in signal-to-clutter plus noise ratio (SCNR) when compared with the conventional methods. [J1228]

"Digital Beamforming on Receive: Techniques and Optimization Strategies for High-Resolution Wide-Swath SAR Imaging"

Synthetic Aperture Radar (SAR) is a well-proven imaging technique for remote sensing of the Earth. However, conventional SAR systems are not capable of fulfilling the increasing demands for improved spatial resolution and wider swath coverage. To overcome these inherent limitations, several innovative techniques have been suggested which employ multiple receive-apertures to gather additional information along the synthetic aperture. These digital beamforming (DBF) on receive techniques are reviewed with particular emphasis on the multi-aperture signal processing in azimuth and a multi-aperture reconstruction algorithm is presented that allows for the unambiguous recovery of the Doppler spectrum. The impact of Doppler aliasing is investigated and an analytic expression for the residual azimuth ambiguities is derived. Further, the influence of the processing on the signal-to-noise ratio (SNR) is analyzed, resulting in a pulse repetition frequency (PRF) dependent factor describing the SNR scaling of the multi-aperture beamforming network. The focus is then turned to a complete high-resolution wide-swath SAR system design example which demonstrates the intricate connection between multi-aperture azimuth processing and the system architecture. In this regard, alternative processing approaches are compared with the multi-aperture reconstruction algorithm. In a next step, optimization strategies are discussed as pattern tapering, prebeamshaping-on-receive, and modified processing algorithms. In this context, the analytic expressions for both the residual ambiguities and the SNR scaling factor are generalized to cascaded beamforming networks. The suggested techniques can moreover be extended in many ways. Examples discussed are a combination with ScanSAR burst mode operation and the transfer to multistatic sparse array configurations. [J1229]

"Sequential Detection and Identification of a Change in the Distribution of a Markov-Modulated Random Sequence"

The problem of detection and identification of an unobservable change in the distribution of a random sequence is studied via a hidden Markov model (HMM) approach. The formulation is Bayesian, on-line, discrete-time, allowing both single- and multiple- disorder cases, dealing with both independent and identically distributed (i.i.d.) and dependent observations scenarios, allowing for statistical dependencies between the change-time and change-type in both the observation sequence and the risk structure, and allowing for general discrete-time disorder distributions. Several of these factors provide useful new generalizations of the sequential analysis theory for change detection and/or hypothesis testing, taken individually. In this paper, a unifying framework is provided that handles each of these considerations not only individually, but also concurrently. Optimality results and optimal decision characterizations are given as well as detailed examples that illustrate the myriad of sequential change detection and identification problems that fall within this new framework. [J1230]

"Detection and Localization of Multiple Unresolved Extended Targets via Monopulse Radar Signal

Processing"

When the size of targets is comparable to the range resolution of monopulse radars, these targets should be considered as extended rather than point targets. If several closely-spaced targets fall within the same radar beam and between adjacent matched filter samples in range, the full monopulse information from all of these samples can and should be used to resolve these targets, i.e., estimate the number of targets and their respective angles-of-arrival and ranges. To detect and localize multiple unresolved extended targets, we establish a model for monopulse radar returns from extended objects, and present a maximum likelihood estimator (MLE) to localize the targets. Rissanen's minimum description length (MDL) criterion will be used to decide the number of existing extended objects. We also derive the upper limit on the number of targets and their scattering centers that can be resolved, and we provide necessary conditions for these targets to be uniquely identified. We compare the new extended target monopulse processing scheme with previously developed point-target monopulse techniques in the simulations. [J1231]

"General aviation aircraft avionics: Integration & system tests"

The avionics of current-day aircraft is termed as modular integrated full glass cockpit. Unlike lots of dials and gauges, the pilot will interact with Multi-Function Displays (MYD). This means that the systems are coupled with multi-function displays, communication and navigation radios with control units, multi-mode interactive instruments for control and navigation, recording and fault management systems, airframes and health monitoring diagnostic capabilities. Pilot Vehicle Interface (PVI) is an important measure of good avionics and cockpit layout, which implies the optimization of man-machine interface, enhancement of the economy, and safety of flight operations. This presents the avionics architecture of a 14-seat Light Transport Aircraft (LTA) for general aviation, which has multi-role commuter capabilities. LTA is a twin turbo-prop, multi-role aircraft, with air taxi and commuter services as its primary roles. The avionics is built on the digital communication mode for both command and control with current requirements of TCAS, digital Autopilot, and AMLCD multi-purpose glass displays. The LTA Avionics suite is grouped into six major groups based on functionality: Display System, Communication System, Navigation System, Recording System, Radar System, and Engine instruments and other cockpit displays. This paper also covers details about the extensive tests carried out to prove the avionics design in terms of functionality, inter-operability, interference, and compatibility. Various practical integration and flight-test issues, methodologies, and details of the scenarios is presented herein. [J1232]

"Airborne along-track interferometry for GMTI"

Synthetic Aperture Radar (SAR) Along-Track Interferometry (ATI) has been used extensively to measure ocean surface currents. Given its ability to measure small velocities (~10 cm/s) of relatively radar-dark water surfaces, there is great potential that this technique can be adapted for ground moving target indication (GMTI) applications, particularly as a method for detecting very slow targets with small radar cross-sections. Herein, we describe preliminary results from an ATI GMTI experiment. The SAR data described were collected by the dual-frequency NASA/JPL airborne radar in its standard dual-baseline ATI mode. The radar system imaged a variety of control targets including a pick-up truck, sport utility vehicles, passenger cars, a bicycle, and pedestrians over multiple flight passes. The control targets had horizontal velocities of less than 5 m/s. The cross-sections of the targets were not purposely enhanced, although the targets' reflectivities may have been affected by the existence of the GPS equipment used to record the targets' positions. Single-look and multiple-look interferograms processed to the full azimuth resolution were analyzed. In the data processed to date, all of the targets were observed by visual inspection in at least one of the four combinations of dual-frequency, dual-baseline interferometric data. This extremely promising result demonstrates the potential of ATI for GMTI applications. [J1233]

"MIMO radar: Snake oil or good idea?"

MIMO communication is theoretically superior to conventional communication under certain conditions, and MIMO communication also appears to be practical and cost-effective in the real world for some applications. It is natural to suppose that the same is true for MIMO radar, but the situation is not so clear. Researchers claim many advantages of MIMO radar relative to phased array radars (e.g., better detection performance, better angular resolution, better angular measurement accuracy, improved robustness against RFI, ECM, multipath, etc.). We will evaluate such assertions from a system engineering viewpoint. In particular, there are serious trade-offs of MIMO vs. phased array radars relative to cost, system complexity, and risk considering numerous real world effects that are not included in most theoretical analyses. Moreover, in many cases one can achieve essentially the same radar system improvement with phased array radars using simpler, less expensive, and less risky algorithms. We evaluate roughly a dozen asserted advantages of MIMO radar relative to phased arrays. [J1234]

"May 2009 distinguished tutorials program"

The Distinguished Tutorials Program (DTP) was established in 2006. Many sections have expressed interest and some are currently in touch with Distinguished Instructors (DIs) to schedule a tutorial. [J1235]

"Complete Link Budgets for Backscatter-Radio and RFID Systems"

Backscatter radio-wireless communication by modulating signals scattered from a transponder (RF tag)-is fundamentally different from conventional radio because it involves two distinct links: the power-up link for powering passive RF tags, and the backscatter link for describing backscatter communication. Because of severe power constraints on the RF tag, a thorough knowledge of the backscatter channel is necessary to maximize backscatter-radio and radio-frequency identification (RFID) system performance. This article presents four link budgets that account for the major propagation mechanisms of the backscatter channel, along with a detailed discussion of each. Use of the link budgets is demonstrated by a practical UHF RFID portal example. The benefits of future 5.8 GHz multi-antenna backscatter-radio systems are shown. An intuitive analogy for understanding the antenna polarization of RF tag systems is presented. [J1236]

"An Adaptive Noise-Filtering Algorithm for AVIRIS Data With Implications for Classification Accuracy"

This paper describes a new algorithm used to adaptively filter a remote-sensing data set based on signal-to-noise ratios (SNRs) once the maximum noise fraction has been applied. This algorithm uses Hermite splines to calculate the approximate area underneath the SNR curve as a function of band number, and that area is used to place bands into ldquobinsrdquo with other bands having similar SNRs. A median filter with a variable-sized kernel is then applied to each band, with the same size kernel used for each band in a particular bin. The proposed adaptive filters are applied to a hyperspectral image generated by the airborne visible/infrared imaging spectrometer sensor, and results are given for the identification of three different pine species located within the study area. The adaptive-filtering scheme improves image quality as shown by estimated SNRs. Classification accuracies of three pine species improved by more than 10% in the study area as compared to that achieved by the same discriminant method without adaptive spatial filtering. [J1237]

"Improved bandwidth-synthesis method of stepped-frequency radar for non-cooperative targets"

During bandwidth synthesis in stepped-frequency radar, amplitude and phase discontinuity between neighbouring pulses should be corrected by a filter. Usually, this filter is constructed by measured data from a calibrator. However, this may be infeasible in non-cooperative situations. Using the signal characteristics after IDFT across received pulses, an improved bandwidth synthesis method based on scatterer alignment is proposed, which neither requires calibration, nor has the serious deficits of the classical IDFT method, such as a limited unambiguous range-profiling window. Analysis of real data collected by a Ka-band radar has verified its advantages. [J1238]

"Flower classification by bats: Radar comparisons"

In recent years, with the development of high-range resolution radars, the desire to identify targets under all weather and clutter conditions has become of great importance. This is an activity carried out with great success by echo-locating mammals such as nectar feeding bats that are able to detect and select flowers of bat-pollinated plants, even in a dense clutter environment. Herein, data consisting of acoustically-generated high-range resolution profiles of four bat-pollinated flower heads are analysed. Multi-perspective classification performance is assessed and compared with the radar case. There are close parallels that suggest lessons can be learnt from nature. [J1239]

"Quantifying Surface Reflectivity for Spaceborne Lidar via Two Independent Methods"

Spaceborne differential absorption lidar has been proposed for accurate measurements of atmospheric CO2(and surface properties). Lidar instruments typically observe the highest possible surface reflectance due to observing in the retroreflection direction (the so-called ldquohotspotrdquo) where viewed shadow is minimized. The range of observed reflectance will determine instrument dimensions and signal-to-noise ratio, but it is difficult to predict this range globally apriori. Two complementary methods are presented for estimating lidar reflectivity over a range of vegetated surface types. The first method simulates the expected response of a lidar instrument from multiangle multispectral reflectance data. The second method uses detailed 3-D vegetation structural models and Monte Carlo ray tracing to simulate the lidar signal. The simulations are used to validate the first method and assess the impact of possible instrument configurations. Both methods agree well and are robust to error in observations, with predicted lidar reflectivity (at 1570 and 2050 nm here) typically between 10% and 33% higher

relative to off-nadir reflectance and ranging from 0.02 to ~ 0.7. We use the 3-D simulations to show that the impact of shifted on-off lidar pulses is not likely to be significant for accuracy of retrieved CO2, and we demonstrate that the 3-D simulation method is a flexible and powerful way of prototyping future spaceborne lidar missions. [J1240]

"Spatial Filtering for Wall-Clutter Mitigation in Through-the-Wall Radar Imaging"

Radio-frequency imaging of targets behind walls is of value in several civilian and defense applications. Wall reflections are often stronger than target reflections, and they tend to persist over a long duration of time. Therefore, weak and close by targets behind walls become obscured and invisible in the image. In this paper, we apply spatial filters across the antenna array to remove, or at least significantly mitigate, the spatial zero-frequency and low-frequency components which correspond to wall reflections. Unmasking the behind-the-wall targets via the application of spatial filters recognizes the fact that the wall electromagnetic (EM) responses do not significantly differ when viewed by the different antennas along the axis of a real or synthesized array aperture which is parallel to the wall. The proposed approach is tested with experimental data using solid wall, multilayered wall, and cinder block wall. It is shown that the wall reflections can be effectively reduced by spatial preprocessing prior to beamforming, producing similar imaging results to those achieved when a background scene without the target is available. [J1241]

"Polarimetric SAR Internal Calibration Scheme Based on T/R Module Orthogonal Phase Coding"

Two important aspects of internal calibration of polarimetric synthetic aperture radar (SAR) are discussed, i.e., individual transmit/receive module (TRM) calibration and system gain calibration. The system has a general structure utilizing a phased array antenna composed of dual-channel TRMs. TRM gain and phase calibration is carried out using orthogonal phase coding (OPC). The signal of the individual TRM is phase-encoded according to a set of orthogonal codes to be separated from the composite calibration signal. OPC uses 1 bit of a digital phase-shifter for encoding, without the need for additional encoding hardware. Performance of the method is examined. Calibration results are developed both theoretically and through simulation in case of TRM amplifier or phase-shifter failure. Zero-padding is used to eliminate calibration error of the first TRM. A crosstalk model is proposed to investigate the effect of imperfect isolation between the two polarization channels of each TRM, and a way to reduce this error is also given. At last, system path gain variation is measured utilizing the internal calibration loop. The OPC method has an accuracy of 0.2 dB for gain and better than 2deg for phase, with 10-dB signal-to-noise ratio and perfect isolation between the two polarization channels. The error due to imperfect isolation is usually small and can be ignored. The simple way to detect TRM malfunction is verified through simulation, and it is also in accordance with TerraSAR-X in-orbit calibration outcomes. The proposed OPC method is shown to be an effective way of internally calibrating TRMs of a phased array antenna. [J1242]

"Electromagnetic Scattering From Objects Above a Rough Surface Using the Method of Moments With Half-Space Green's Function"

An efficient approach is proposed to analyze the electromagnetic scattering from objects above a 2-D perfectly electric conducting rough surface. A half-space Green's function with the rough-surface interface is first derived from the Kirchhoff approximation (KA). The method of moments is then applied to analyze the scattering problem of 3-D arbitrarily shaped objects above the rough surface. Since only the objects need to be discretized, the computational time and memory requirement are greatly reduced. The radar cross sections of typical objects above the rough surface have been computed using the proposed method. Numerical results show that the proposed method has good accuracy in the valid range of KA. [J1243]

"Element failure detection in linear antenna arrays using case-based reasoning"

The present work proposes a novel case-based reasoning system for fault diagnosis in moderate or large linear antenna arrays. This system identifies the set of elements that are most likely to be defective, helping to significantly reduce the computational costs of their detection (e.g., using an optimization technique such as a genetic algorithm). [J1244]

"AMTA Corner"

Welcome once again to the latest edition of the AMTA Corner. As usual, we sit down to write this issue's AMTA corner with the deadline approaching and with lots to talk about. Jeff and I are both very appreciative that AP-S Magazine Editor-in- Chief Ross Stone has given us a little space to get everyone caught up on what is happening in AMTA (as well as giving us a little extension to complete the corner). Since AMTA "El Presidente" Jeff is busy preparing for this year's symposium, I will give a quick summary of upcoming events. [J1245]

"Submicrosecond Scan-Angle Switching Photonic Beamformer With Flat RF Response in the C and X Bands"

A wideband (>10 GHz) beamformer, based on a photonic true-time-delay, with submicrosecond scan-angle switching is reported. The smooth microwave transmission (ripples <0.5 dB and <3deg) and superb uniformity among the elements (<0.1 dB and <0.5deg) are then used for the processing of 1 GHz-wide linear frequency modulation (LFM) signals in both the C and X bands with excellent performance. This performance is also maintained under dynamic operation, where a fast tunable laser is employed to provide <300 ns wavelength-controlled angle scanning. Based on these characteristics, an optimized architecture, where a photonic beamformer feeds a series of classical subarrays, can offer high performance in both the time and spatial domains for large, wideband phased-array antennas, with wide scan angles. [J1246]

"AP-S Distinguished Lecturer Program"

{no data available} [J1247]

"A phase shifter with one tunable component for a reflectarray antenna"

The combination of a dipole and a tunable varactor forms a phase shifter with one tunable component that provides a phase shift over a wide range, from 0deg to nearly 360deg. The dipole, loaded with a tunable varactor, is used as a patch component of a low-profile reflectarray antenna. An economic assessment shows that the production price of the suggested phase shifter with one tunable component is more than 10 times smaller than the price of the traditional phase shifter, based on p-i-n diode components. The design of such a phase shifter is the goal of this paper. Simulations of the phase shift and loss of the reflected wave as a function of control voltage applied to the varactor were used, based on an analytical model verified by fullwave analysis. The results of simulations are in agreement with measurements. The fast and correct simulation of the reflection coefficient from the dipole loaded with the tunable varactor can be used for the design and optimization of a low profile steerable reflectarray antenna. [J1248]

"Solving large complex problems using a higher-order basis: parallel in-core and out-of-core integral-equation solvers"

The future of computational electromagnetics is changing drastically with the new generation of computer chips, which are multi-cored instead of single-cored. Previously, advancements in chip technology meant an increase in clock speed, which was typically a benefit that computational code users could enjoy. This is no longer the case. In the new roadmaps for chip manufacturers, speed has been sacrificed for improved power consumption, and the direction is multi-core processors. The burden now falls on the software programmer to revamp existing codes and add new functionality to enable computational codes to run efficiently on this new generation of multi-core processors. In this paper, a new roadmap for computational code designers is provided, demonstrating how to navigate along with the chip designers through the multi-core advancements in chip design. A new parallel code, using the method of moments (MoM) and higher-order functions for expansion and testing, and executed on a range of computer platforms, will illustrate this roadmap. The advantage of a higher-order basis over a subdomain basis is a reduction in the number of unknowns. This means that with the same computer resources, a larger problem can be solved using higher-order basis than using a subdomain basis. The matrix filling for MoM with subdomain basis must be programmed with multiple loops over the edges of the patches to account for the interactions. However, higher- order basis functions, such as polynomials, can be calculated more efficiently with fewer integrations, at least for the serial code. In terms of parallel integral-equation solvers, the differences between these categories of basis functions must be understood and accommodated. [J1249]

"High-Speed High-Isolation 2 2 Fiber-Optic Switch for Wideband Radar Photonic Beamforming Controls"

A new high-performance 2 x 2 fiber-optic switch is designed and demonstrated for wideband radar photonic beamforming controls. The switch deploys two bulk acoustooptic deflectors (AODs) in an imaging free-space symmetric optical design that exploits image inversion control via a Dove prism to form a 2 X 2 fully reversible low crosstalk noise high-speed switching structure. Experiments at the 1550-nm test wavelength show the switch to handle 0.5-W level optical input powers, < 2.2-mus switching time, <2.6-dB fiber-to-fiber optical loss, better than 56-dB optical crosstalk levels, and <0.2-dB polarization-dependent loss (PDL).and <0.2-dB polarization-dependent loss (PDL). Index terms-delay lines, optical switches, phased-array radar. [J1250]

"Making ethical engineering-management decisions in a competitive environment (part 2 of 2)"

The following case studies illustrate the complexities of making engineering-management decisions in a competitive environment. Engineering managers, who have the responsibility of making tradeoff decisions to meet design and performance requirements while completing the project within a given cost and time frame, must accomplish all of this without jeopardizing the safety of the users. The specific case studies examined below pertain to the 1986 space shuttle Challenger tragedy. [J1251]

"Practical uncertainty of pulse power measurements in Ka-band RCS instrumentation"

The output level of pulsed radar transmitter and receiver test sets can be defined with spectrum analyzers and diode detectors. Modern analyzers, which have 10 MHz or wider resolution bandwidths and cover appropriate input frequency ranges, can be used in the Ka- and V-band radar domains for pulse widths above about 200 ns. A practical uncertainty of 2 dB is obtainable. External mixers seem to show larger-level discrepancies, up to 5 dB, and may give only 20 dB of dynamic range. Their conversion loss may vary by 8 dB over just 500 MHz. Diodes work at higher power levels, but rise-time definitions are complicated. Above -15 dBm input levels, we can get uncertainties comparable to spectrum analyzers, but the true dynamic range can be just 15 dB, and temperature effects may hamper outdoor trials. Below 200 ns pulse widths, radar-receiver test-generator level calibration remains very challenging in the millimeter-wave bands due to inadequate sensitivity, regardless of the measuring instrumentation. [J1252]

"Some Reflections on Bistatic SAR of Forward-Looking Configuration"

Forward-looking imaging has many potential applications, but it is impossible with the usual monostatic synthetic aperture radar (SAR) principle. Through the bistatic SAR configuration, forward-looking imaging can be realized for one of the bistatic platforms. This letter designs a bistatic configuration with a stationary transmitter and a forward-looking airborne receiver. It then analyzes the 2-D resolution and finds out which geometric parameter affects the imaging ability mostly. Besides, it gives out the signal formulation in the frequency domain and shows its imaging characteristics. Then, an imaging method is chosen for this special configuration, and the simulation results are exhibited, which validate the correctness of the analysis and prove the 2-D imaging ability of forward-looking bistatic SAR. [J1253]

"Using Multibaseline InSAR to Recover Layovered Terrain Considering Wideband Array Problem"

This letter deals with the problems of retrieving height and synthetic aperture radar (SAR) reflectivity of layovered terrain using multibaseline SAR interferometry (InSAR). In particular, we focus on the wideband array problem caused by practically large InSAR arrays and high-resolution SAR images, i.e., the problem of signal envelope misalignment, which is neglected in the work by Gini We propose two methods to eliminate or mitigate the effect of envelope misalignment, one called the aligning method and the other called the joint range cell processing method. In the aligning method, we align each signal envelope for each searched height of the layovered components (i.e., ground resolution cells with different altitudes) during searching procedure. The joint range cell processing method jointly processes the neighboring cells in range to estimate the parameters of layovered components so that the effect of the envelope misalignment can be mitigated. Theoretical analysis and computer simulation results show that both methods have the ability to provide accurate estimation of the heights and radar reflectivities of multiple layovered resolution cells in the presence of large envelope misalignments. [J1254]

"Ground Moving Target Indication With Tandem Satellite Constellations"

Ground moving target indication (GMTI) from space by existing dual-channel radar systems such as TerraSAR-X and RADARSAT-2 has been shown to perform only insufficiently with respect to the relocation error of targets to their true ground position. Only two parallel receiver channels are too little to suppress the severe ground clutter and to estimate the target's parameters. Although this deficiency may partly be alleviated through antenna aperture switching, the resulting positioning accuracy is still not adequate for effective traffic monitoring purposes. Satisfactory results are only achievable with extended apertures, primarily with satellite constellations. This letter presents a statistical analysis of the performance of different concepts for cooperating back-to-back flying satellite systems. Particularly in anticipation of TanDEM-X, which will form the first operational GMTI-capable coherent synthetic aperture radar constellation after its launch in 2009. [J1255]

"The Polar Format Imaging Algorithm Based on Double Chirp-Z Transforms"

Spotlight mode offers finer azimuth resolution than that achievable in stripmap mode using the same physical antenna. The most popular spotlight synthetic aperture radar (SAR) reconstruction method is the classic polar format algorithm (PFA). However, PFA needs to perform range and azimuth interpolation operations during SAR imaging, which, in turn, affect the imaging precision and the computation efficiency. In this letter, we present a novel polar format algorithm, which may avoid interpolation operations by double chirp-Z transform. In this letter,

we also analyze the nondefocus and the nondistortion constraints and discuss the along-track acceleration constraint for the PFA as well. [J1256]

"Optimum Transparent Absorbers of Electromagnetic Waves"

Electromagnetic wave absorbers consisting of thin transparent sheets of conducting medium are studied in this paper. In particular, a result known since the 1930 s that, for plane waves normally incident on a conducting sheet, the maximum achievable absorption is one half of the incident power is proved and generalized to multiple layers. The case of arbitrary incidence angle and polarization is discussed and illustrated with examples, and the resistance providing maximum absorption when the angle of incidence and polarization is arbitrary is derived. We also consider an absorber consisting of two resistive sheets and optimize its resistances to yield the best possible absorption for normal incidence, such that the total absorption at all frequencies is ges 0.5. Finally, conditions for an optimal absorber for a spherical sheet surrounding a dipole antenna are derived. [J1257]

"Modified Hough Transform for Searching Radar Detection"

In this letter, we propose a modified Hough transform (HT) algorithm for radar detection by shifting the parameter space cells as well as exploiting the phase information of signal. The proposed modified HT brings (1) significant improvement of radar target detection at low signal-to-noise ratios and (2) complexity reduction of HT implementation in radar detection applications compared to the conventional HT-based methods. Simulation results are presented showing the performance gain obtained by the proposed modified HT over the conventional methods. [J1258]

"A Novel Algorithm for Estimating the Rotation Angle in ISAR Imaging"

A novel algorithm for estimating the rotation angle in inverse synthetic aperture radar imaging by generally considering the received signals as cubic phase signals is presented. The rotation angle is determined by the coefficients of the cubic phase signals, and the results of real data demonstrate the validity of the algorithm. [J1259]

"Fundamentals of spatial and Doppler frequencies in radar STAP"

The increasing interest for arbitrary antenna arrays in radar space-time adaptive processing (STAP) creates a need for a thorough understanding of the role of, and dependencies between, spatial and Doppler frequencies and related quantities, especially in the characterization of clutter. We successively introduce ldquogeometricalrdquo and statistical concepts, where we respectively emphasize the 4D direction-Doppler (DD) curve and the 4D power spectral density (PSD) that characterize the (clutter) space-time field. These descriptors, which are flight-configuration dependent, but antenna independent, are fundamental since they can be used to derive the key spectral properties of any antenna, essentially by rotations and projections. These descriptors are related in various ways, mostly because the DD curve is the support of the ridge of the clutter PSD. We also emphasize the surprising benefits of systematically considering the three spatial frequencies that are always present behind the scene, even for the customary linear antenna. A solid, simple, and elegant basis for thinking about STAP for arbitrary measurement configurations and antenna arrays is provided. [J1260]

"KUPS: Knowledge-based ubiquitous and persistent sensor networks for threat assessment"

We propose a knowledge-based ubiquitous and persistent sensor network (KUPS) for threat assessment, in which "sensor" is a broad characterization. It refers to diverse data or information from ubiquitous and persistent sensor sources such as organic sensors and human intelligence sensors. Our KUPS for threat assessment consists of two major steps: situation awareness using fuzzy logic systems (FLSs) and threat parameter estimation using radar sensor networks (RSNs). Our FLSs combine the linguistic knowledge from different intelligent sensors, and our proposed maximum-likelihood (ML) estimation algorithm performs target radar cross section (RCS) parameter estimation. We also show that our ML estimator is unbiased and the variance of parameter estimation matches the Cramer-Rao lower bound (CRLB) if the radar pulses follow the Swerling II model. Simulations further validate our theoretical results. [J1261]

"Target detection and parameter estimation for MIMO radar systems"

We investigate several target detection and parameter estimation techniques for a multiple-input multiple-output (MIMO) radar system. By transmitting independent waveforms via different antennas, the echoes due to targets at different locations are linearly independent of each other, which allows the direct application of many data-dependent beamforming techniques to achieve high resolution and excellent interference rejection capability. In the absence of array steering vector errors, we discuss the application of several existing data-dependent

beamforming algorithms including Capon, APES (amplitude and phase estimation) and CAPES (combined Capon and APES), and then propose an alternative estimation procedure, referred to as the combined Capon and approximate maximum likelihood (CAML) method. Via several numerical examples, we show that the proposed CAML method can provide excellent estimation accuracy of both target locations and target amplitudes. In the presence of array steering vector errors, we apply the robust Capon beamformer (RCB) and doubly constrained robust Capon beamformer (DCRCB) approaches to the MIMO radar system to achieve accurate parameter estimation and superior interference and jamming suppression performance. [J1262]

"Radar target resolution probability in a noise-limited environment"

This paper investigates the probability of a radar being able to resolve two point-targets in an environment in which additive noise is the primary limitation on resolution. The statistical properties of the radar cross-ambiguity function are developed and used to arrive at an expression for the target resolution probability. The analysis is verified through simulations. [J1263]

"Multiple-Mode Selection of Walled-LTSA Array Elements for High-Resolution Imaging to Visualize Antipersonnel Plastic Landmines"

We propose a resolution improvement technique for a high-density array of walled linearly tapered slot antennas (LTSAs) in ground-penetrating radar imaging. In the system, we use the walled-LTSA array in a near-field measurement configuration and select various pairs of transmitter and receiver antennas out of the array elements. We prepare four selection modes so that we can practically enhance the imaging resolution. We remove the direct-coupling effect and compensate the path-length fluctuation caused by element individuality and element selection. Experiments demonstrate that the technique realizes higher resolution image acquisition to yield a clearer segmentation of antipersonnel plastic landmines in combination with adaptive image processing, based on complex-amplitude texture, even on a wet laterite soil condition. [J1264]

"On the Superresolution of Microwave Scanning Radiometer Measurements"

Microwave radiometer measurements are exploited to extract important geophysical information. Although it is beneficial to merge different frequency channels, it requires extra effort to refer all measurements to a common spatial resolution. Therefore, the capability to enhance the spatial resolution of a single channel is of special interest. In this study, a new numerical procedure to get superresolution microwave scanning radiometer measurements is presented. The approach is physically based on the occurrence of multiple partially correlated measurements. Mathematically, the approach is equivalent to a linear inversion problem, and its solution is pursued by means of a superresolution numerical procedure based on the Tikhonov regularization method. A set of numerical examples illustrates the results of the study in which hypothetical scanning microwave radiometer sensor configuration and reference test cases have been considered. [J1265]

"A Physical Full-Resolution SAR Ship Detection Filter"

Synthetic aperture radar (SAR) ship detection is an important application in the context of environment and security monitoring. It allows monitoring traffic, fisheries, and associating ships with oil discharge over wide areas with high spatial resolution almost independently from weather conditions and both day and night time. Since full-resolution SAR images are heavily affected by the presence of speckle, ship detection algorithms generally employ speckle reduced SAR images at the expense of a degradation of the spatial resolution. A new physical approach, which considers ships as dominant scatterers and, therefore, responsible for a strong and coherent backscattered signal, is here proposed. Based on this rationale, a new simple and very effective filtering technique, which is able to process full-resolution SAR images, has been conceived and implemented. Experiments, accomplished over C-band European Remote Sensing satellite (ERS) 1/2 single-look complex SAR images, show the effectiveness of the proposed approach. [J1266]

"Synthetic Aperture Hitchhiker Imaging"

We introduce a novel synthetic-aperture imaging method for radar systems that relies on sources of opportunity. We consider receivers that fly along arbitrary, but known, flight trajectories and develop a spatio-temporal correlation-based filtered-backprojection-type image reconstruction method. The method involves first correlating the measurements from two different receiver locations. This leads to a forward model where the radiance of the target scene is projected onto the intersection of certain hyperboloids with the surface topography. We next use microlocal techniques to develop a filtered-backprojection-type inversion method to recover the scene radiance. The method is applicable to both stationary and mobile, and cooperative and noncooperative sources of opportunity. Additionally, it is applicable to nonideal imaging scenarios such as those involving arbitrary flight trajectories, and has the desirable property of preserving the visible edges of the scene radiance. We present an

analysis of the computational complexity of the image reconstruction method and demonstrate its performance in numerical simulations for single and multiple transmitters of opportunity. [J1267]

"The Compact Polarimetry Alternative for Spaceborne SAR at Low Frequency"

In spaceborne synthetic aperture radar (SAR), a single-polarization on-transmit offers twice the swath width compared to full polarization. This is linked to SAR system design issues, and, without getting into the technical details deserving by themselves a full paper, we can just mention the swath characteristics of ALOS PALSAR (the Advanced Land Observing Satellite, Phased Array L-Band Synthetic Aperture Radar), reducing from 70 km for the dual-pol mode to 30 km for the full polarization mode. The reduced coverage in the full polarization mode has a harmful impact on the revisit time, which is always a major drive for the Earth-observing community. The options chosen up to now for dual-pol system designs (or single-polarization on-transmit) rely on a linear polarization on-transmit [either horizontal (H) or vertical (V)], with two orthogonal polarizations on-receive. Souyris and Raney in earlier papers proposed more pertinent alternatives for the selection of the transmit polarization leading to a better characterization of the scattering mechanisms. In this paper, the analysis is pursued in more depth by including the effect of the ionosphere on the wave propagation and extending the applications to polarimetric interferometry SAR (PolInSAR). A compact mode is developed where the transmit polarization is circular, whereas the only constraint on the two receiving polarizations is independence. Indeed, the choice of the polarizations of the two receive channels does not matter, as any polarization on-receive can be synthesized from these two measurements. This is, however, not the case for the unique transmit polarization. At a low frequency, where the ionosphere has a significant effect, the circular transmit polarization is the only sensible option, as it provides an effective constant polarization as seen by the scattering surface. This is an essential condition for a meaningful multitemporal analysis. Both the polarimetric SAR applications and the PolInSAR appl--ications in the context of this compact polarimetry (CP) mode are explored. A pseudocovariance matrix can be reconstructed following Souyris' proposed approach for distributed targets and is shown to be very similar to the full polarimetric (FP) covariance matrix. The reconstruction of the cross-polarized Sigma0 is shown to be reliable and to have very low sensitivity to Faraday rotation. A PolInSAR vegetation height inversion for P-band is presented and applied to the CP data with a level of performance that is similar to the one derived from FP (a 1.2-m root-mean-square height error on the ONERA Airborne radar (RAMSES) data over the Landes Forest). A procedure is developed to correct for the ionospheric effects for the PolInSAR acquisition in the FP or CP mode and is assessed on the data simulated from an airborne acquisition. The results demonstrate that the technique is efficient and robust. The calibration of CP data is identified as an important challenge to be solved, and some clues are provided to address the problem. [J1268]

"Measurement and Characterization of Entropy and Degree of Polarization of Weather Radar Targets"

To date, few polarimetric weather radars have exhibited the capability to measure full scattering matrices. In contrast, in the synthetic aperture radar (SAR) community, considerable experience has been gained in dealing with complete scattering matrices and their statistical behavior. This paper aims to place weather radar parameters in a wider context in order to exploit more general concepts like target decomposition theorems and polarization basis transformations. Entropy, which is a fully polarimetric variable derived from the Cloude-Pottier decomposition, and the degree of polarization, which is derived from Wolf's coherence matrix, are the subject of this paper. The theoretical analysis carried out in the first part is checked against fully polarimetric data from POLDIRAD, which is the german aerospace center research weather radar. The entropy and the degree of polarization are compared with the copolar correlation coefficient in order to understand whether they can add value to radar meteorological investigations. Because the degree of polarization is available to conventional dual-polarization coherent systems, it is important to assess its potential for operational use. [J1269]

"Impact of Sun Glint on Salinity Remote Sensing: An Example With the Aquarius Radiometer"

The Aquarius/SAC-D mission will employ three L-band (1.41 GHz) radiometers dedicated to the remote sensing of sea surface salinity. The radiation from the Sun reflected at the ocean surface toward the radiometer is an important source of interference for retrieving salinity; in fact, the mission will be in a dawn/dusk Sun-synchronous orbit with the beams oriented toward the night side of the orbit in order to limit this signal. In this paper, the effect of ocean surface roughness on the reflected radiation is examined. The reflected Sun radiation can be separated into two components: (1) a quasi-specular component and (2) a scattered component, due largely to small-scale roughness. We show that the first component has a large brightness temperature but, in the Aquarius geometry, is located far from the antenna boresight. The scattered component has relatively small brightness temperature but can extend to the antenna boresight where the gain is maximum. This can occur at high latitude near the summer solstice when the antenna footprint is not in shadow and can cause significant contamination. While the calculations have been done for the specific geometry of the Aquarius instrument, the

conclusions drawn regarding the effect of roughness on the reflected solar radiation are characteristic of remote sensing at L-band. [J1270]

"Classification With a Non-Gaussian Model for PolSAR Data"

In this paper, we present a generalized Wishart classifier derived from a non-Gaussian model for polarimetric synthetic aperture radar (PolSAR) data. Our starting point is to demonstrate that the scale mixture of Gaussian (SMoG) distribution model is suitable for modeling PolSAR data. We show that the distribution of the sample covariance matrix for the SMoG model is given as a generalization of the Wishart distribution and present this expression in integral form. We then derive the closed-form solution for one particular SMoG distribution, which is known as the multivariate K-distribution. Based on this new distribution for the sample covariance matrix, termed as the K-Wishart distribution, we propose a Bayesian classification scheme, which can be used in both supervised and unsupervised modes. To demonstrate the effect of including non-Gaussianity, we present a detailed comparison with the standard Wishart classifier using airborne EMISAR data. [J1271]

"Principle and Methods on Bistatic SAR Signal Processing via Time Correlation"

In this paper, we discuss the mapping between the 3-D scene space and the bistatic synthetic aperture radar (SAR) image space and show that when the direction of the angular velocity of the bistatic SAR remains constant, the process of bistatic SAR imaging can be approximately modeled as a perspective operator from the 3-D scene space to the 2-D image space, and the perspective line is perpendicular to the plane determined by the composition direction of the T/R line of sight and the composition direction of the angular velocity of the T/R platform. Then, we show that the 2-D point spread function of the bistatic SAR is determined not only by the range and ldquoazimuthrdquo resolutions but also by the geometry of the bistatic SAR and the bases of the SAR image space, and the concept ldquoambiguity regionrdquo is introduced to describe the ambiguity problem in the 3-D scene space. Then, the range-Doppler algorithm is discussed, and a new translational-variant bistatic SAR imaging method is proposed, which uses the scaled inverse fast Fourier transform (IFFT) technique to eliminate the translational-variant feature of the SAR space resolution. The space truncation error of this new algorithm is discussed to analyze the depth of focus of the scaled IFFT bistatic SAR imaging algorithms, and we find that the upper bounce of the space truncation error is proportional to the square of the distance from the scatterer to the T/R platforms. Last, the effects of motion measurement errors are discussed in detail, and, through theoretical analysis and numerical experiments, we show that the absolute position measurement error, the baseline measurement error, the perpendicular (vertical) component of the absolute velocity measurement error (AVME), and the perpendicular component of the relative velocity measurement error (RVME) cause SAR image shifting in the image space mainly, and the parallel component of the AVME and the parallel component of the RVME cause the SAR image to s--everely defocus. [J1272]

"Correction of the Sea State Impact in the L-Band Brightness Temperature by Means of Delay-Doppler Maps of Global Navigation Satellite Signals Reflected Over the Sea Surface"

This paper presents an efficient procedure based on 2-D convolutions to obtain delay-Doppler maps (DDMs) of Global Navigation Satellite Signals reflected (GNSS-R) over the sea surface and collected by a spaceborne receiver. Two DDM-derived observables (area and volume) are proposed to link the sea-state-induced brightness temperature to the measured normalized DDM. Finally, the requirements to use Global Positioning System reflectometry to accurately correct for the sea state impact on the L-band brightness temperature (quantization levels, decimation, truncation, and noise impact) are analyzed in view of its implementation in the Passive Advanced Unit instrument of the Spanish Earth Observation Satellite (SeoSAT/INGENIO) project. [J1273]

"Prediction, Detection, and Correction of Faraday Rotation in Full-Polarimetric L-Band SAR Data"

With the synthetic aperture radar (SAR) sensor PALSAR onboard the Advanced Land Observing Satellite, a new full-polarimetric spaceborne L-band SAR instrument has been launched into orbit. At L-band, Faraday rotation (FR) can reach significant values, degrading the quality of the received SAR data. One-way rotations exceeding 25 degare likely to happen during the lifetime of PALSAR, which will significantly reduce the accuracy of geophysical parameter recovery if uncorrected. Therefore, the estimation and correction of FR effects is a prerequisite for data quality and continuity. In this paper, methods for estimating FR are presented and analyzed. The first unambiguous detection of FR in SAR data is presented. A set of real data examples indicates the quality and sensitivity of FR estimation from PALSAR data, allowing the measurement of FR with high precision in areas where such measurements were previously inaccessible. In examples, we present the detection of kilometer-scale ionospheric disturbances, a spatial scale that is not detectable by ground-based GPS measurements. An FR prediction method is presented and validated. Approaches to correct for the estimated FR

effects are applied, and their effectiveness is tested on real data. [J1274]

"Glacier Volume Changes Using ASTER Satellite Stereo and ICESat GLAS Laser Altimetry. A Test Study on EdgeШуа, Eastern Svalbard"

Currently, one of the major methodological gaps in the observation of glaciers from space is the measurement of volume changes of mountain glaciers and ice caps. In this paper, we present a case study of comparing a digital elevation model derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite optical stereo, elevation data derived from Ice, Cloud, and land Elevation Satellite Geoscience Laser Altimeter System (GLAS) laser altimetry, and contour lines from a topographic map from the 1970s. For two ice caps in Eastern Svalbard, Kvalpyntfonna and Digerfonna, we obtain an overall elevation change of -0.55 or -0.61 m/year between 1970 and 2002 (ASTER) or GLAS (2006), respectively. From comparison of different methods and from different quality checks, we estimate the error of this numbers to be on the order of 5%. This paper demonstrates that and on how long-term glacier volume changes can be observed from space over a large number of ice caps and glaciers. [J1275]

"Evaluation and Bias Removal of Multilook Effect on Entropy/Alpha/Anisotropy in Polarimetric SAR Decomposition"

Entropy, alpha, and anisotropy (H/alpha/A) of the polarimetric target decomposition have been an effective and popular tool for polarimetric synthetic aperture radar (SAR) image analysis and for a geophysical parameter estimation. However, multilook processing can severely affect the values of these parameters. In this paper, a Monte Carlo simulation is used to evaluate and remove the bias generated by the multilook effect on these parameters for various media composed of grassland, forest, and urban returns. Due to insufficient averaging, entropy is underestimated, and anisotropy is overestimated. We also found that the bias in the alpha angle can be either underestimated or overestimated depending on scattering mechanisms. Based on simulation results, efficient bias removal procedures have been developed. In particular, the entropy bias can be precisely corrected, and the amount of correction is independent of the radar frequency and SAR systems. Data from L-band Advanced Land Observing Satellite/phased array type L-band SAR, German Aerospace Research Center (DLR)/enhanced SAR, Jet Propulsion Laboratory (JPL)/airborne SAR, and X-band polarimetric and interferometric SAR are used for demonstration in this paper. [J1276]

"An Autofocus Approach for Residual Motion Errors With Application to Airborne Repeat-Pass SAR Interferometry"

Airborne repeat-pass SAR systems are very sensible to subwavelength deviations from the reference track. To enable repeat-pass interferometry, a high-precision navigation system is needed. Due to the limit of accuracy of such systems, deviations in the order of centimeters remain between the real track and the processed one, causing mainly undesirable phase undulations and misregistration in the interferograms, referred to as residual motion errors. Up to now, only interferometric approaches, as multisquint, are used to compensate for such residual errors. In this paper, we present for the first time the use of the autofocus technique for residual motion errors in the repeat-pass interferometric context. A very robust autofocus technique has to be used to cope with the demands of the repeat-pass applications. We propose a new robust autofocus algorithm based on the weighted least squares phase estimation and the phase curvature autofocus (PCA) extended to the range-dependent case. We call this new algorithm weighted PCA. Different from multisquint, the autofocus approach has the advantage of being able to estimate motion deviations independently, leading to better focused data and correct impulse-response positioning. As a consequence, better coherence and interferometric-phase accuracy are achieved. Repeat-pass interferometry based only on image processing gains in robustness and reliability, since its performance does not deteriorate with time decorrelation and no assumptions need to be made on the interferometric phase. Repeat-pass data of the E-SAR system of the German Aerospace Center (DLR) are used to demonstrate the performance of the proposed approach. [J1277]

"Remote Sensing Observation Used in Offshore Wind Energy"

Remote sensing observations used in offshore wind energy are described in three parts: ground-based techniques and applications, airborne techniques and applications, and satellite-based techniques and applications. Ground-based remote sensing of winds is relevant, in particular, for new large wind turbines where meteorological masts do not enable observations across the rotor-plane, i.e., at 100 to 200 m above ground level. Light detection and ranging (LiDAR) and sound detection and ranging (SoDAR) offer capabilities to observe winds at high heights. Airborne synthetic aperture radar (SAR) used for ocean wind mapping provides the basis for detailed offshore wind farm wake studies and is highly useful for development of new wind retrieval algorithms from C-, L-, and X-band data. Satellite observations from SAR and scatterometer are used in offshore

wind resource estimation. SAR has the advantage of covering the coastal zone where most offshore wind farms are located. The number of samples from scatterometer is relatively high and the scatterometer-based estimate on wind resources appears to agree well with coastal offshore meteorological observations in the North Sea. Finally, passive microwave ocean winds have been used to index the potential offshore wind power production, and the results compare well with observed power production (mainly land-based) covering nearly two decades for the Danish area. [J1278]

"Digital rights management for the home TV based on scalable video coding"

In this paper, the business model and digital rights management (DRM) solution are proposed for the home TV based on scalable video coding and convergent networks. In this environment, the TV program is broadcasted via digital video broadcasting for handheld terminals (DVB-H) to mobile phones, the access right is transmitted by Global System for Mobile communication (GSM/GPRS) channel, and the TV program can also be transmitted from mobile phones to home TV through WiFi. The typical application scenario is that the TV program with low quality (base layer) in the mobile phone can be enriched by enhancement information and shown on home TV. The business model is presented to pay for the enhancement information, and the DRM solution is proposed for solving the copyright issues in the convergence between the DVB-H broadcasting, GSM/GPRS and home network. Since few work has been done to solve this problem, the work proposed in this paper is expected to attract more researchers. [J1279]

"Model-Based Interpretation of High-Resolution SAR Images of Buildings"

High-resolution (HR) synthetic aperture radar (SAR) images of urban areas reveal a large variety of details that, although potentially bringing a lot of information, are often very difficult to interpret. Until now, most of the research activity in this field has been devoted to the attempt to retrieve geometric information on buildings in terms of their positions and sizes, by using simplified geometrical models. However, this approach does not allow us to fully exploit the large amount of information present in HR SAR images. In order to improve information retrieval from such images, and, hence, their interpretation, in this paper, we propose to employ a more refined model that accounts for both geometrical (including fine details) and electromagnetic properties of the building. A meaningful case study is presented to show that the main features appearing on the SAR image of a building can be interpreted by using our geometric and electromagnetic model. In addition, a first example of retrieval of the complex dielectric constant of building materials from a SAR image is presented. [J1280]

"Feature Extraction and Visualization of Bridges Over Water From High-Resolution InSAR Data and One Orthophoto"

Modern airborne SAR sensor systems provide geometric resolution in the order well below half a meter. By SAR interferometry from pairs of such images, DEM of the same grid size can be obtained. In data of this kind, many features of urban objects become visible, which were beyond the scope of radar remote sensing only a few years ago. However, because of the side-looking SAR sensor principle, layover and occlusion issues inevitably arise in undulated terrain or urban areas. Therefore, SAR data are difficult to interpret even for senior human interpreters. Furthermore, the quality of the InSAR DEM may vary significantly depending on the local topography. In order to support interpretation, SAR data are often analyzed using additional complementary information provided by maps or other remote sensing imagery. In this paper, object feature extraction and visualization from high-resolution InSAR data and one orthophoto is discussed for the example of a scene containing several bridges over water. Bridges are key elements of man-made infrastructure. Monitoring of these important connecting parts of the traffic network is vital for applications such as disaster management or in the context of political crisis, for instance, to evacuate inhabitants and to deliver goods and equipment. Aims of the approach are to derive key features of the bridge's geometry from the complementary data sources, to determine the water level, smooth the noisy InSAR DEM data, especially at water surfaces, and, finally, to generate an improved 3-D visualization of the scene by overlapping the optical image on the InSAR DEM. [J1281]

"Evaluation of Underwater Rainfall Measurements During the Ionian Sea Rainfall Experiment"

Rainfall on the sea surface generates a loud and distinctive sound underwater. This sound propagates downward and attenuates, producing an effective listening area or an equivalent ldquo catchmentbasinrdquo for a listening device that is a function of depth and frequency. Acoustical measurements of rainfall are reported from four passive aquatic listeners (PALs) at 60-, 200-, 1000-, and 2000-m depths from a mooring in the Ionian Sea off the southwestern coast of Greece (37N, 21.5E) from January to April 2004. These measurements are compared to colocated high-resolution X-band dual-polarization (XPOL) radar rainfall measurements. The XPOL radar reports the spatial distribution of rainfall variability over the listening areas of the PALs. Four quality-controlled rainfall events, including drizzle, squall line, and heavy rainfall, are presented in this study. The radar

rainfall is spatially averaged over the mooring and compared with the four different acoustic measurements at different depths. To understand the issue of spatial averaging, quantitative comparisons are presented, showing a high correlation between the acoustic measurements and the area-averaged radar estimates at corresponding resolutions. [J1282]

"Radar Imaging of Urban Areas by Means of Very High-Resolution SAR and Interferometric SAR"

In remote-sensing applications, the monitoring of urban areas by means of synthetic aperture radar (SAR) sensors has grown into a valuable and indispensable tool. Although SAR imaging with a spatial resolution down to 1 m is widespread, a resolution as fine as 10 cm and below is offered only by very few SAR sensors worldwide. In this paper, the potential of very high-resolution radar imaging of urban areas by means of SAR and interferometric imaging will be demonstrated and discussed. Results of urban SAR imaging down to subdecimeter resolution will be shown. Even though the immanent layover situation in urban areas is an obstacle to simple image understanding, a remedy can be found by using interferometric SAR imaging. Interferometric results based on very high-resolution SAR images acquired over urban areas, partially with a severe layover situation, will be presented. The corresponding data was acquired with the phased array multifunctional imaging radar (PAMIR), the X-band demonstrator of the Research Institute for High Frequency Physics and Radar Techniques (FHR), Forschungsgesellschaft fur Angewandte Naturwissenschaften (FGAN), Wachtberg, Germany. It can be stated that high-resolution interferometric SAR will be an important basis for upcoming radar-based urban analysis. [J1283]

"Wide-Area Traffic Monitoring With the SAR/GMTI System PAMIR"

This paper presents a wide area traffic monitoring experiment under real conditions, using the scan-MTI mode of the airborne radar sensor PAMIR. This flexible GMTI (Ground Moving Target Indication) mode was designed in order to rapidly monitor wide areas for moving targets. The scan operation enables the detection of targets from different aspect angles with a high revisit rate. The parameters (e.g., radial velocity, signal-to-noise ratio, and positioning accuracy) of the detected vehicles are investigated and compared to the expected theoretical GMTI performance. It will be shown that the scan-MTI mode is particularly adapted to perform an efficient wide-area traffic monitoring. [J1284]

"Evaluation of X-Band Polarimetric-Radar Estimates of Drop-Size Distributions From Coincident S-Band Polarimetric Estimates and Measured Raindrop Spectra"

Recent research has demonstrated the value of polarimetric measurements for the correction of rain-path attenuation at X-band radar frequency and the estimation of rain parameters including drop-size distributions (DSD). The issue this paper is concerned with is to what degree uncertainties in attenuation correction can affect the estimation of DSD. Since attenuation-correction uncertainty enhances with rain path, our hypothesis is that DSD retrieval uncertainty at X-band may deteriorate with range. In this paper, we evaluate the relative accuracy of X-band DSD retrieval against DSD estimates from S-band radar observations and insitudisdrometer spectra. We present comparisons of various techniques for estimating DSD model parameters from attenuation-corrected X-band dual-polarization radar data. Coincident X-band polarimetric-radar (XPOL) and S-band polarimetric-radar dual-polarized radar measurements from the International H2O Project experiment as well as coincident XPOL (MP-X) measurements over disdrometer during a typhoon storm case in Japan are used to assess the accuracy of the different DSD retrieval algorithms applied to X-band radar measurements. [J1285]

"A Contrast-Based Algorithm For Synthetic Range-Profile Motion Compensation"

In stepped-frequency radar, target motions produce range-profile distortions. Range shift, signal-to-noise ratio loss, and symmetric spreading are produced by target radial velocity, whereas target radial acceleration is mainly responsible for asymmetric smearing. Acceleration-distortion effects are usually negligible when a high Pulse Repetition Frequency (PRF) is used, although this is not the case for low-PRF radars. In this paper, a new motion-compensation technique based on contrast optimization is proposed. The innovative contributions of this paper are as follows: (1) A theoretical analysis of the distortions produced by target motions on the reconstruction of synthetic aperture radar is provided; (2) the proposed technique compensates both phase terms, which are due to target radial velocity and acceleration; therefore, synthetic range profiles can be focused by processing low-PRF radar returns; (3) a new cost function for the synthetic range profiles (namely, contrast) is defined and used for motion compensation; (4) the proposed technique can be applied to any kind of stepped-frequency waveforms; and (5) an estimation error analysis is performed, first theoretically and then by means of both simulations and real data. [J1286]

"Additional Corrections to “Unconstrained Inversion of Waveheight Spectra From SAR Image”

[JFeb 02 261-270]"

Lyzenga's paper ("Unconstrained inversion of waveheight spectra from SAR images" IEEE Trans. Geosci. Remote Sens., vol. 40, no. 2, pp. 261-270, Feb. 2002) after being corrected (ibid., vol. 40, no. 3, p. 729, Mar. 2002) has still a few remaining errors. This paper presents the additional corrections. [J1287]

"Theory and Application of Motion Compensation for LFM-CW SAR"

Small low-cost high-resolution synthetic aperture radar (SAR) systems are made possible by using a linear frequency-modulated continuous-wave (LFM-CW) signal. SAR processing assumes that the sensor is moving in a straight line at a constant speed, but in actuality, an unmanned aerial vehicle (UAV) or airplane will often significantly deviate from this ideal. This nonideal motion can seriously degrade the SAR image quality. In a continuous-wave system, this motion happens during the radar pulse, which means that existing motion compensation techniques that approximate the position as constant over a pulse are limited for LFM-CW SAR. Small aircraft and UAVs are particularly susceptible to atmospheric turbulence, making the need for motion compensation even greater for SARs operating on these platforms. In this paper, the LFM-CW SAR signal model is presented, and processing algorithms are discussed. The effects of nonideal motion on the SAR signal are derived, and new methods for motion correction are developed, which correct for motion during the pulse. These new motion correction algorithms are verified with simulated data and with actual data collected using the Brigham Young University muSAR system. [J1288]

"Measurements of the Effect of Rain-Induced Sea Surface Roughness on the QuikSCAT Scatterometer Radar Cross Section"

Radar measurements of the sea surface, with satellite scatterometers that operate at Ku-band, are affected by the presence of rain through modification of the sea surface roughness by rain impacts. This is in addition to wind driven roughness, atmospheric scattering, and attenuation that affect the measured normalized radar cross section (NRCS). This paper presents a case study of the increase of the total radar cross section, averaged across surface illuminated areas (individual footprints) of the SeaWinds scatterometer (on QuikSCAT) caused by rain striking the sea surface. This effort combines satellite-based Ku-band data with high-resolution 3-D volumetric rain measurements, from simultaneous collocated Next Generation Weather Radar data. The results to be presented were acquired during a significant rain event in the Gulf of Mexico, to the east of Corpus Christi, and just south of Houston, TX, in May 2005. The results of this paper show dependence on wind speed, rainrate, and polarization. They agree with numerous surface-based studies (single point measurements), using ocean platforms and wind-wave tanks, whose data were collected under similar conditions. For example, at rainrates less than 10 mm/hr, the relative change in surface roughness is seen to decrease as the wind magnitude increases from 5 to 7 m/s. Another consistent observation is that the vertical polarization NRCS shows less sensitivity to rainrate than does horizontal. [J1289]

"Estimation of Hurricane Winds From SeaWinds at Ultrahigh Resolution"

Although the SeaWinds scatterometer was not specifically designed to observe tropical cyclones, new high-resolution wind products resolve much of the horizontal structure of these storms. However, these higher resolution products (2.5 km) are inherently noisier than the standard 25-km near-surface wind products. These noise levels combined with rain contamination complicate high-resolution wind estimation-particularly in tropical cyclones. Fortunately, tropical cyclones have structures that can be exploited by using a wind field model. This paper develops a new procedure for hurricane wind field estimation from the SeaWinds instrument at ultrahigh resolution. A simplified hurricane model is developed to provide prior information to be used in maximum aposterioriprobability estimation of ocean winds. Using the hurricane model ameliorates the effects of rain and noise and provides useful hurricane parameters such as the eye center location. The model also improves ambiguity selection. The new method reduces the variability of the wind speed and direction estimates, although high wind speeds still tend to be underestimated. The method also greatly improves wind direction estimates in hurricanes-even in rain-contaminated portions of the storm. [J1290]

"Fast Chirplet Transform With FPGA-Based Implementation"

This letter presents a fast chirplet transform (FCT) algorithm, a computationally efficient method, for decomposing highly convoluted signals into a linear expansion of chirplets. The FCT algorithm successively estimates the chirplet parameters in order to represent a broad range of chirplet shapes, including the broadband, narrowband, symmetric, skewed, nondispersive, or dispersive. These parameters have significant physical interpretations for radar, sonar, seismic, and ultrasonic applications. For the real-time application and embedded implementation of the FCT algorithm, an FPGA-based hardware/software co-design is developed on Xilinx Virtex-II Pro FPGA development platform. Based on the balance among the system constraints, cost, and the efficiency of

estimations, the performance of different algorithm implementation schemes have been explored. The developed system-on-chip successfully exhibits robustness in the chirplet transform of experimental signals. The FCT algorithm addresses a broad range of applications including velocity measurement, target detection, deconvolution, object classification, data compression, and pattern recognition. [J1291]

"Guest EditorialSpecial Section on the 2007 International Conference on Near-Field Imaging and Characterization (ICONIC'07)"

The four papers in this special section present a sparse but diverse sampling of some of the prominent near-field imaging techniques for very different applications. [J1292]

"Array Modeling of Active Sonar Clutter"

Active sonar systems operating in shallow-water environments often deal with excessive false alarms, generically referred to as clutter, that are more numerous than expected for Rayleigh-distributed reverberation. The clutter probability density function, and therefore the probability of false alarm (Pfa), depends on the scattering sources, propagation conditions, sonar system, and signal processing. Clutter statistics are often approximated by the K-distribution where the shape parameter (alpha macr) provides an inverse relationship to Pfawith decreases in alpha macr representing an increase in Pfa. In this paper, the effect of sonar array processing on clutter statistics is evaluated by first modeling clutter at the hydrophone level and then analyzing the resulting K-distribution shape parameter after conventional beamforming. When the transmit-waveform bandwidth is narrowband with respect to the array processing and propagation consists primarily of low-angle paths, alpha macr was found to be separable into the product of a clutter-source scattering effect, an array processing effect, and a coupled transmit-waveform and propagation effect. The array effect was found to coarsely follow the array beamwidth, although precise evaluation is straightforward given the array beampattern. As might be expected, array design or processing that tends to increase the beamwidth was found to increase alpha macr. Uniform shading was seen to provide a practical, though not exact, lower bound on alpha macr for common array shading functions. For circular arrays with unaliased spatial sampling, an asymptotic beampattern was found to provide a very accurate approximation to alpha macr. These results should be useful in predicting the performance of sonar systems in clutter dominated areas, in the design of arrays and array processing, in the inversion of clutter data for clutter-source scattering parameters, or--to improve signal processing algorithms aiming to reduce or control clutter-related false alarms. [J1293]

"Cognitive radio modulation techniques"

The growing demand on wireless communication systems to provide high data rates has brought with it the need for a flexible and efficient use of the spectrum resource, which is a scarce commodity. The regional spectrum allocation policy counteracts the free mobility of radio communication equipment. The vast majority of the available spectral resources have already been licensed, so it appears that there is little or no room to add any new services, unless some of the existing licenses are discontinued. Furthermore, recent studies and measurements have shown that vast portions of the licensed spectra are rarely used due to the inflexible spectrum regulations. The whole idea behind cognitive radio (CR) use is that it should prompt effective spectrum use, since intelligence and learning processes aid the radio system to access the spectrum effectively. The CR system has learning and understanding capabilities so that the stated goals may be achieved. In this article, we shall limit the scope of cognition to reduce mutual interference between CR-based rental (unlicensed) users (RUs) and licensed users (LUs) and in providing coexistence between them. It is expected that the rental users will be allowed to transmit and receive data over portions of spectra when primary (i.e., licensed) users are inactive. In this article, we will introduce the modulation strategies employed to realize a coexistence between the CR-based rental system and the licensed system. This is done in such a way that the RUs are invisible to the LUs. We consider the rental user accesses the unoccupied LU band in overlay fashion. [J1294]

"Transmit codes and receive filters for radar"

This article's main goal is to show how to design the receive filter (including its length) and the transmit code sequence via the optimization of a number of relevant metrics considered separately or in combination. Several numerical studies are given to illustrate the performance of the presented designs. Compared with most of the previously published works on the subject, the present contribution is more coherent as well as more complete, and yet the approach taken here is generally simpler both conceptually and computationally. Finally, weremark on the fact that while the focus is on radar systems, for the sake of being specific, the theory and design methods presented should be useful to several other active sensing applications, such as sonar, nondestructive testing, seismic exploration, and biomedical imaging. [J1295]

"Imaging Small PEC Spheres by a Linear Approach"

The problem of localizing small inhomogeneities from the knowledge of their scattered field is dealt with. In particular, the case of small perfect electric conducting spheres is of concern, with the scattered field data collected under multistatic/multifrequency/single-view or multistatic/single-frequency/multiview far zone configurations. The multiple scattering between the spheres is neglected, and their locations are represented as the supports of the Dirac delta functions. This allows one to cast the problem as the inversion of a linear integral operator, with the delta functions being the unknowns of the problem. The inversion of this linear integral operator is achieved by means of the truncated singular value decomposition. The performance of the linear inversion algorithm against the model error (i.e., for situations where the multiple scattering is not negligible) is investigated by numerical simulations. Furthermore, the effect of noise is also analyzed by corrupting the data by an uncorrelated additive white Gaussian process. [J1296]

"Radar Bistatic Configurations for Soil Moisture Retrieval: A Simulation Study"

The possible contribution of bistatic radar measurements for bare soil moisture retrieval is investigated in this paper. A simulation study based on well-established electromagnetic models of rough surface scattering (both coherent and incoherent components) has been accomplished for this purpose. The retrieval accuracy has been evaluated by using both the Cramer-Rao lower bound and the error variance of a linear regression estimator, thus considering slightly different assumptions on retrieval conditions. Both methods have allowed us to identify the optimal system configurations in terms of observation directions, polarizations, and frequency. This identification has been carried out for single-polarization and multipolarization receivers and for the case in which bistatic measurements are complemented by monostatic ones, which are expected to be available through already-existing spaceborne synthetic aperture radars. The optimal systems have first been singled out by considering a Gaussian autocorrelation function (ACF) and a constant value of correlation length. Successively, the simulations for an exponential ACF and a variable correlation length have been analyzed, demonstrating that the results substantially remain the same. The comparison between the soil moisture estimation accuracy yielded by the optimal configurations and that provided by the standard monostatic radar has shown that a significant improvement in the quality of retrieval can be achieved by complementing bistatic and monostatic measurements. [J1297]

"An Improved NLCS Algorithm With Capability Analysis for One-Stationary BiSAR"

This paper deals with the imaging problem of one-stationary bistatic SAR (BiSAR) with large bistatic angle. An improved nonlinear chirp scaling (NLCS) algorithm is proposed for this BiSAR. The main work here includes three aspects. First, a range chirp scaling function for correcting the differential range cell migration correction is derived. Then, the azimuth perturbation is generated by local fit method, which makes the NLCS algorithm suitable for the large bistatic angle case. Furthermore, the negative effects introduced by the perturbation (including phase error and locality error) are discussed, and some compensation methods are proposed to enhance the capability of the algorithm. The simulating results exhibited at the end of this paper validate the correctness of the analysis and the feasibility of the algorithm. [J1298]

"Statistical Characterization and Modeling of Raindrop Spectra Time Series for Different Climatological Regions"

A large data set of raindrop size distribution (RSD) measurements collected with the Joss-Waldvogel disdrometer (JWD) and the 2-D video disdrometer (2DVD) in the U.K., Greece, Japan, and the U.S. are analyzed and modeled. This work extends a previous effort devoted to the exploitation of U.K. data and the design of a stochastic procedure to randomly generate synthetic RSD intermittent time series. This study seeks to: (1) explore the differences of RSD-derived moments for distinct hydroclimate regions, ranging from tropics to subtropics and mid and northern latitudes; (2) compare the governing parameters of the normalized gamma RSD for both stratiform and convective events and perform a sensitivity analysis by using different best fitting techniques; (3) exploit the time-correlation structure of the estimated RSD parameters as the input of a vector autoregressive stationary model used to simulate time series (or horizontal profiles) of RSDs and, consequently, its moments as the rain rate and concentration; and (4) characterize the distribution of the inter-rain duration and rain duration to design a semi-Markov chain to represent the intermittency feature of the rainfall process in a climatological framework. This climatological analysis and the related stochastic RSD generation model may find useful applications within both hydrometeorology and radio propagation. [J1299]

"A Comparison of Algorithms for Retrieving Soil Moisture from ENVISAT/ASAR Images"

In this paper, we present an intercomparison of algorithms for retrieving soil moisture content (SMC) from

ENVIronmental SATtellite (ENVISAT)/Advanced Synthetic Aperture Radar images. The algorithms taken into consideration were a feedforward artificial neural network (ANN) with two hidden layers, a statistical approach based on Bayes' theorem, and an iterative algorithm based on the nelder-mead direct-search method. The comparison was carried out by using both simulated and experimental data. Simulated data were obtained by means of the integral equation model (IEM). Experimental data were collected in an agricultural area in Northern Italy during 2003-2005; they included backscattering coefficient at HH and HV polarizations and at an incidence angle of thetas = 23deg, as well as detailed ground truth measurements of SMC, surface roughness, and vegetation parameters. HH-polarized data were related to SMC, whereas the information of the cross-polarized channel was used to correct the backscatter for the effects of surface roughness. A comparison of the algorithms with experimental data showed that all the tested approaches produced SMC values that are very close to the measured ones. However, the predictions of the ANN were slightly more suitable than the other methods for generating maps in reasonable time. The production of moisture maps carried out at different dates using this algorithm pointed out the feasibility of separating up to six levels of spatial/temporal variations of SMC in the range of 10%-35%. [J1300]

"Calibration Method for Fully Polarimetric Microwave Radiometers Using the Correlated Noise Calibration Standard"

In this paper, a new and improved L-band version of the correlated noise calibration standard (CNCS) has been developed to aid in the characterization of polarimetric microwave radiometers. The CNCS generates a series of known polarimetric test signals using a two-channel commercial arbitrary waveform generator (AWG) and a pair of frequency-upconversion modules. When it is inserted in place of the antenna used by a radiometer-under-test (RUT), it can fully characterize the polarimetric response of the receiver portion of the RUT. Both hardware and software improvements have been made over a previous version of the CNCS. The frequency upconverters now include integral warm and cold calibration-reference targets to automatically compensate for small drifts in AWG output-signal strength. The procedure used to calibrate the RUT has been generalized to correct for nonideal characteristics of the CNCS itself. Moreover, the effects on the derived polarimetric gain matrix of impedance mismatches between the RUT, and either the CNCS or the antenna have been determined. Details of the CNCS improvements are presented. The results of an experimental demonstration of its use and of a series of validation tests of its performance are also presented. [J1301]

"A Kirchhoff-Based Shape Reconstruction Algorithm for the Multimonostatic Configuration: The Realistic Case of Buried Pipes"

A shape reconstruction algorithm is formulated for the multimonostatic configuration and the 2-D geometry. The imaging algorithm is based on the Kirchhoff approximation, works in the frequency domain, and exploits the singular value decomposition tool to achieve a stable solution. The effectiveness of the reconstruction algorithm is shown by processing synthetic data in the time domain generated via a finite-difference time-domain code. A performance analysis of the solution algorithm is addressed with varying host medium and measurement configurations, also by processing synthetic data for a 3-D geometry. Finally, an experimental validation of the technique is performed due to data collected by a time-domain ground-penetrating radar for buried pipe detection and localization. [J1302]

"Land Use and Land Cover Mapping in the Brazilian Amazon Using Polarimetric Airborne P-Band SAR Data"

In September 2000, an airborne synthetic aperture radar (SAR) mission acquired unprecedented full polarimetric P-band data over the Tapajos National Forest (Para State), which is an area in the Brazilian Amazon which has been continuously monitored in the last three decades. Eight land use/cover classes were identified, namely, primary forest, regeneration older than 25 years, regeneration between 12 and 25 years, regeneration between 6 and 12 years, regeneration younger than six years, crops/pasture, bare soil, and floodplain (FP). The objective of this paper is to analyze the potential of full polarimetric P-band data in distinguishing different land use/cover classes with a minimum established Kappa value of 75%, using the latest development on SAR statistical characterization. The iterated conditional mode (ICM) contextual classifier was applied to amplitude, intensity images, biomass index, and some polarimetric parameters (entropy, alpha angle, and anisotropy) extracted from the polarimetric P-band data. As the accuracy obtained for eight classes was not acceptable, another two sets, with five and four classes, were formed by the combination of the previous ones. They were defined by confusion matrix analysis and by the graphical analysis of average backscatter values, entropy, [alpha] angle, and anisotropy images and by the H/alpha plans of the land use samples. The classification accuracy with four classes (three levels of biomass plus FP) was then considered acceptable with a Kappa value of 76.81%, using the ICM classification with the adequate bivariate distribution for the HV and VV channels. [J1303]

"An Approach for Solving Rank-Deficient Systems That Enable Atmospheric Path Delay and Water Vapor Content Estimation"

This paper develops mathematical techniques and makes use of interferometric synthetic aperture radar (InSAR) for improving the quality of digital elevation models derived from SAR images and providing accurate estimations of atmospheric path and absolute phase delays and water vapor content estimation. The problem of solving parameters such as atmospheric path delay, height, and unwrapping errors is to be described in a mathematical form that uses QR factorization techniques for solving rank-deficient systems. A new approach for the solution of rank-deficient systems with few independent equations is proposed. In the new approach, the bounds are considered known and provided by the eigenvalues. New eigenvalues are added inside the bounds. During the implementation, attention is given not to exceed the bounds of the reorganized matrix. This approach is the first time that is used for phase parameterization in terms of height, tropospheric delay, and phase unwrapping errors. Expanding the approach was also studied for absolute phase delay and water vapor content estimation. The investigation and the implementation of the approach make use of ENVISAT images. The validation of results was implemented through GPS and meteorological measurements. [J1304]

"A-Train Data Depot: Bringing Atmospheric Measurements Together"

This paper describes the satellite data processing and services that constitute current functionalities of the A-Train Data Depot. We first provide a brief introduction to the original geometrical intricacies of the platforms and instruments of the A-Train constellation and then proceed with a description of our A-Train collocation-processing algorithm that provides subsets that facilitate synergistic use of the various instruments. Finally, we present some sample image products from our web-based Giovanni tool which allows users to display, compare, and download coregistered A-Train-related data. [J1305]

"Observing and Modeling Multifrequency Scattering of Maize During the Whole Growth Cycle"

The objective of this paper is to carry out a systematic investigation about the sensitivity of radar to maize crop growth and soil moisture by considering a wide range of frequencies and angles and all linear polarizations. We show the results of a correlation study carried out on the data collected on a maize field at Suberg, in the Swiss region named Central Plain, by the multifrequency RAdio ScAtteroMeter (RASAM). This agricultural field was monitored over a long period of time at a wide range of frequencies and observation angles so that the correlation between the backscattering and crop height and the biomass and soil moisture was studied under several plant and observation conditions. Moreover, we describe some recent refinements applied to the vegetation scattering model developed at Tor Vergata University, Rome, Italy, and we evaluate the accuracy of extended comparisons between model outputs and RASAM signatures. The Tor Vergata model is finally applied to give a theoretical basis to the experimental correlation findings. [J1306]

"Comparing Scatterometric and Radiometric Simulations With Geophysical Model Functions to Tune a Sea Wave Spectrum Model"

A unified approach to simulate both microwave radiometric and scatterometric observations over a sea surface based on the two-scale electromagnetic scattering model has been implemented. The simulations have been compared with empirically derived geophysical model functions (GMFs) for the purpose of tuning the electromagnetic forward model and the embedded sea surface characterization and wave spectrum. The comparison has concerned a large number of wind speeds, frequencies, and observation angles for both the passive and active cases. Two widely adopted literature spectra have been used as benchmarks. A new expression for the hydrodynamic modulation function has been developed too. The proposed new spectrum has allowed us to reproduce both the passive and active GMFs' behaviors fairly well, generally improving the agreement yielded by literature models, particularly for scatterometric simulations. [J1307]

"Model-Based Polarimetric SAR Speckle Filter"

In this paper, a new framework to filter speckle noise in polarimetric synthetic aperture radar (PolSAR) data is presented. The proposed filter, named the model-based PolSAR (MBPolSAR) filter, is based on exploiting the multiplicative-additive speckle noise model for multidimensional SAR data. The entries of the sample covariance matrix are processed according to this multiplicative-additive speckle noise model as a function of the complex correlation coefficient. Hence, the covariance matrix elements are processed differently. This filtering scheme improves the reduction of speckle noise and ameliorates the estimation of the polarimetric information. The filtering performances of the MBPolSAR approach are first tested quantitatively by means of simulated PolSAR data. In a second stage, they are evaluated by means of experimental SAR data acquired by the Deutsches Zentrum fu umlr Luft-und Raumfahrt. [J1308]

"Particle Filtering Based Approach for Landmine Detection Using Ground Penetrating Radar"

In this paper, we present an online stochastic approach for landmine detection based on ground penetrating radar (GPR) signals using sequential Monte Carlo (SMC) methods. The processing applies to the two-dimensional B-scans or radargrams of 3-D GPR data measurements. The proposed state-space model is essentially derived from that of Zoubir etal., which relies on the Kalman filtering approach and a test statistic for landmine detection. In this paper, we propose the use of reversible jump Markov chain Monte Carlo in association with the SMC methods to enhance the efficiency and robustness of landmine detection. The proposed method, while exploring all possible model spaces, only expends expensive computations on those spaces that are more relevant. Computer simulations on real GPR measurements demonstrate the superior performance of the SMC method with our modified model. The proposed algorithm also considerably outperforms the Kalman filtering approach, and it is less sensitive to the common parameters used in both methods, as well as those specific to it. [J1309]

"Surface-Tracing-Based LASAR 3-D Imaging Method via Multiresolution Approximation"

This paper concerns the surface-tracing-based (STB) linear-array synthetic-aperture-radar (LASAR) 3-D imaging technique. The basic idea of this technique is to consider the 3-D SAR imaging problem as tracing a surface in the low height-resolution level. The STB 3-D imaging technique first initiates a low-resolution digital elevation map (DEM) using 3-D backprojection (BP) algorithm, predicts a higher resolution DEM from the known elevation using multivariate-interpolation technique, searches from the predicted elevation and obtains a higher resolution DEM, then repeats the prediction and searching recursively and obtains the fine-resolution DEM finally. By converting the 3-D LASAR imaging problem to a 2-D surface-tracing problem, the STB 3-D imaging technique can reduce the computational complexity by one order. The computational cost of STB 3-D imaging technique is analyzed, and we find out that the computational cost of STB 3-D LASAR imaging technique is determined by the surface prediction error and the fluctuation of ground. In particular, for normal distribution, when one of the earlier two factors is small, the computational cost is proportional to the other factor approximately. Finally, a new STB 3-D BP algorithm that implements the surface-prediction operation via multiresolution-approximation (MRA) technique (named as MRA 3-D BP algorithm) is presented. By operating the interpolation in frequency domain, the computational cost of MRA algorithm for sparse LASAR is near to that of RD algorithm for full-element LASAR. [J1310]

"Feature Extraction and Discriminator Design for Landmine Detection on Double-Hump Signature in Ultrawideband SAR"

An air- or vehicleborne ultrawideband synthetic aperture radar (UWB SAR) has ground penetrating capability, which provides a sufficient approach to detect landmines over wide areas from a safe standoff distance. In this paper, a support vector machine (SVM) with hypersphere classification boundary, which is referred to as HyperSphere-SVM (HS-SVM), using a hidden Markov model (HMM) kernel on the feature vector extracted by a postfilter-based method is proposed for landmine detection. The postfilter-based method can extract the feature containing not only the amplitude but also the amplitude varying information of the double-hump signature of metallic and plastic landmines. Compared with simple kernels, e.g., the Gaussian kernel, the HMM kernel employs the state-transition information in the extracted feature into the discrimination procedure and, thus, can improve detection performance. The proposed postfilter-based feature extraction method and the HMM kernel HS-SVM are verified on the field data collected by a UWB SAR system in different scenarios. [J1311]

"Snow Facies Over Ice Sheets Derived From Envisat Active and Passive Observations"

This paper aims to separate different snow regions over the terrestrial ice sheets based on their measured microwave signatures. It takes advantage of coregistered data from passive and active sensors on the Environmental Satellite (Envisat) to directly derive a snow facies indicator in a point-by-point basis. This paper represents the first attempt of this kind in exploiting nadir-viewing and dual-frequency data from both altimeter and radiometer sensors. The approach is based on a clustering method. Such representation of the data by means of fewer clusters necessarily loses fine details but achieves simplification in geographical representation and eases the description of the condition of the ice sheets in 2004. Our approach broadens the description of the snow pack by taking into account characteristics such as surface roughness, grain size, stratification, and snowmelt effects, whereas the latter has often solely been considered in most previous work. Such partition of the ice sheets might help to better understand relationships between microwave signatures and snow morphology. It could also be useful for estimating elevation uncertainty in altimeter data, which, in turn, is essential to correctly interpret the significance of the rates of elevation change in a changing climate and to convert elevation change to snow mass change. [J1312]

"Estimation of Urban Green Volume Based on Single-Pulse LiDAR Data"

Estimating urban green volume is getting more and more important within the frame of an ecologically orientated city planning and environmentally sustainable development. The first and the last pulse of airborne Light Detection and Ranging (LiDAR) data provide the basis for the estimation of green volume, but these optimal data are not always available, particularly for urban areas. That is why this paper deals with the question whether LiDAR data (last pulse only) that have not been taken during the vegetation period allow a sufficient estimation of the green volume. This paper sets up on previous results where LiDAR data have been compared to photogrammetrically determined vegetation height measurements. The subtraction of the laser-based Digital Terrain Model and Digital Surface Model in vegetated areas leads to a vast underestimation of green volume of up to 85%, which is mainly due to the standing deciduous trees with an underestimation of 90%. Starting from the existence of different laser response characteristics of various vegetation types, the relative point density and the normalized height of classified nonground points were analyzed in depth. The results show a good separation of different vegetation types. Furthermore, a pragmatic approach of reconstruction of the underestimated vegetation (mainly deciduous trees) is carried out by generating cylinders for the classified nonground points to compensate the volume loss. The point density of nonground points and the normalized height of the laser responses were used to regulate the adaptive cylinder construction based on fuzzy logic techniques. Using reference data, the accuracy could be estimated. In spite of the suboptimal LiDAR data, this paper leads to a sufficiently exact and efficient estimation of green volume compared to the costly conventional methods like field investigations. The method makes a contribution in the field of data improvement and is applicable to similar LiDAR data of other areas. [J1313]

"Efficient FFT-Accelerated Approach to Invariant Optical-LIDAR Registration"

This paper presents a fast Fourier transform (FFT)-accelerated approach designed to handle many of the difficulties associated with the registration of optical and light detection and ranging (LIDAR) images. The proposed algorithm utilizes an exhaustive region correspondence search technique to determine the correspondence between regions of interest from the optical image with the LIDAR image over all translations for various rotations. The computational cost associated with exhaustive search is greatly reduced by exploiting the FFT. The substantial differences in intensity mappings between optical and LIDAR images are addressed through local feature mapping transformation optimization. Geometric distortions in the underlying images are dealt with through a geometric transformation estimation process that handles various transformations such as translation, rotation, scaling, shear, and perspective transformations. To account for mismatches caused by factors such as severe contrast differences, the proposed algorithm attempts to prune such outliers using the random sample consensus technique to improve registration accuracy. The proposed algorithm has been tested using various optical and LIDAR images and evaluated based on its registration accuracy. The results indicate that the proposed algorithm is suitable for the multimodal invariant registration of optical and LIDAR images. [J1314]

"CloudSat's Cloud Profiling Radar After Two Years in Orbit: Performance, Calibration, and Processing"

The Cloud Profiling Radar, the sole science instrument of the CloudSat Mission, is a 94-GHz nadir-looking radar that measures the power backscattered by hydrometeors (clouds and precipitation) as a function of distance from the radar. This instrument has been acquiring global time series of vertical cloud structures since June 2, 2006. In this paper, an overview of the radar performance and status, to date, is provided together with a description of the basic data products and the surface clutter rejection algorithm introduced for the Release 04 data product release. [J1315]

"On the Exploitation of Target Statistics for SAR Interferometry Applications"

This paper focuses on multiimage synthetic aperture radar interferometry (InSAR) in the presence of distributed scatterers, paying particular attention to the role of target decorrelation in the estimation process. This phenomenon is accounted for by splitting the analysis into two steps. In the first step, we estimate the interferometric phases from the data, whereas in the second step, we use these phases to retrieve the physical parameters of interest, such as line-of-sight (LOS) displacement and residual topography. In both steps, we make the hypothesis that target statistics are at least approximately known. This approach is suited both to derive the performances of InSAR with different decorrelation models and for providing an actual estimate of LOS motion and topography. Results achieved from Monte Carlo simulations and a set of repeated pass ENVISAT images are shown. [J1316]

"Phase Synchronization and Doppler Centroid Estimation in Fixed Receiver Bistatic SAR Systems"

This paper discusses temporal and phase synchronization in bistatic synthetic aperture radar (SAR) systems that use orbital sensors as coherent sources of opportunity and receivers at a fixed location. The discussion is particularized to SAR Bistatic Receiver for INterferometric Applications (SABRINA), a ground-based bistatic receiver that uses ENVISAT and ERS-2 as transmitters. Transmitter-receiver synchronization is hindered by the presence of independent reference oscillators at the transmit and receive end and by the lack of a common time frame. Phase synchronization and pulse alignment are achieved using a dedicated channel that receives a clean signal directly from the satellite. How to align the acquired data with the satellite orbit and how to estimate the Doppler centroid (DC) are studied. It is shown that in the bistatic configuration considered, the receiver provides an implicit control point which limits the negative impact of a DC misestimation on the resulting images. An algorithm to achieve this temporal alignment using the apparent phase history of the received pulses is proposed. Finally, this algorithm is validated through Monte Carlo simulations and experimental data acquired by SABRINA. [J1317]

"High-Resolution and Real-Time Three-Dimensional Imaging Algorithm With Envelopes of Spheres for UWB Radars"

Ultrawideband pulse radars have a great potential for high-range resolution in near field imaging and can be used for noncontact measuring in precision or specular products such as reflector antennas and aircraft fuselages. We have already proposed a high-speed 3-D imaging algorithm, SEABED, which is based on a reversible transform, which is the boundary scattering transform, between the received signals and the target shape. However, the estimated image with SEABED is unstable with random noise because it utilizes a derivative of the received data. In this paper, we propose a robust 3-D imaging algorithm with an envelope of spheres that completely resolves the instability due to derivative operations. Moreover, to enhance the resolution of estimated images, this method is combined with a direct waveform compensation method that does not sacrifice high-speed calculation. Numerical simulations and an experiment confirm that the proposed method can realize fast, robust, and high-resolution 3-D imaging for arbitrary targets. [J1318]

"Complete complementary codes and generalized reed-muller codes"

Due to ideal autocorrelation and cross-correlation properties, complete complementary codes (CCCs) can be employed in CDMA systems to eliminate the multiple-access interference. In this letter, we propose a direct general construction of CCCs from cosets of the first-order Reed-Muller codes, which includes previous results as a special case. The larger number of CCCs constructed by our method can provide advantages in applications to cellular CDMA systems. [J1319]

"Ocean Surface Currents From AVHRR Imagery: Comparison With Land-Based HF Radar Measurements"

We focus on inverting the surface temperature (or heat) equation to obtain the surface velocity field in the coastal ocean and compare the results with those from the maximum cross correlation (MCC) technique and with the insituvelocity fields measured by the Rutgers University Coastal Ocean Dynamics Radar (CODAR). When compared with CODAR fields, velocities from the heat equation and MCC have comparable accuracies, but the heat equation technique better resolves the finer scale flow features. We use the results to directly calculate the surface divergence and vorticity. This is possible because we convert the traditionally underdetermined heat inversion problem to an overdetermined one without constraining the velocity field with divergence, vorticity, or energy statements. Because no aprioriassumptions are made about the vorticity, it can be calculated directly from the velocity results. The derived vorticity field has typical open-ocean magnitudes (~ 5 times 10-5/s) and exhibits several structures (a warm core ring, Gulf Stream filament, and a diverging flow) consistent with the types of flows required to kinematically deform the sea surface temperature patterns into the observed configurations. [J1320]

"Imaging of Micromotion Targets With Rotating Parts Based on Empirical-Mode Decomposition"

For micromotion targets with rotating parts, the inverse synthetic-aperture-radar image of the main body may be shadowed by the micro-Doppler. To solve this problem, this paper proposes an imaging algorithm based on the complex-valued empirical-mode decomposition. First, the radar echoes are decomposed into a series of complex-valued intrinsic-mode functions (IMFs). Then, the IMFs from the rotating parts and those from the main body are separated according to the characteristics of their zero-crossings. Finally, the well-focused imaging of the main body via traditional imaging algorithm and the accurate parameter estimation of the rotating part can be obtained. Both the imaging results for the simulated and measured data are given to verify the validity of the proposed algorithm. [J1321]

"Squint LFMCW SAR Data Processing Using Doppler-Centroid-Dependent Frequency Scaling Algorithm"

A linear frequency-modulated continuous-wave (LFMCW) synthetic aperture radar (SAR) is a highly miniaturized SAR that is suitable for use on a small unmanned aerial vehicle. In squint stripmap mode, the LFMCW SAR image quality is degraded by the presence of nonlinearities in the transmitted signal, combined with the large bandwidth introduced by the frequency scaling in the nonlinear frequency scaling (NLFS) algorithm. This paper proposes an extension of the NLFS algorithm called the Doppler-centroid-dependent frequency scaling algorithm. The algorithm introduces a new Doppler-centroid-dependent scaling factor to decrease the introduced bandwidth, effectively removing the range frequency aliasing, without extra computational load. Nonlinearity correction is performed at the same time as range cell migration correction. The validity of the proposed algorithm is demonstrated with point target simulation results. [J1322]

"Simultaneous three-wavelength depolarization measurements of clouds and aerosols using a coherent white light continuum"

Lidar (light detection and ranging) depolarization measurements were performed simultaneously at three wavelengths using a coherent white light continuum. The white light continuum ranging from the ultraviolet to the infrared region was generated by a focused 0.5 TW/100 fs pulse in a krypton gas cell at the atmospheric pressure. The lidar system consisted of three depolarization channels at 450, 550, and 800 nm. The observed depolarization ratios for each wavelength showed differences for clouds. These depolarization features in wavelength are discussed in terms of particle size and shape using T-matrix computations. The depolarization ratios at three wavelengths can be used to infer information on the size of the particles in clouds, assuming an ice crystal shape a priori. Also, the obtained size distributions from the three-wavelength depolarization ratios correspond with the changes in particle size indicated by changes in the Angstrom coefficient obtained by multiwavelength lidar techniques. This study demonstrated that the three-wavelength depolarization ratios provided additional information about the size and shape of clouds and aerosols. [J1323]

"A scattering and absorption identity for metamaterials: Experimental results and comparison with theory"

A dispersion relation for the combined effect of scattering and absorption of electromagnetic waves is presented for a large class of linear and passive material models. By invoking the optical theorem, the result states that the extinction cross section integrated over all frequencies is equal to the static limit of the extinction volume. The present paper focuses on an attempt to experimentally verify this sum rule by measuring the monostatic radar cross section of a fabricated sample of metamaterial. In particular, the paper utilizes the idea that, for a specific class of targets, the scattered fields in the forward and backward directions are identical. It is concluded that the theoretical findings are in good agreement with measurements performed in the frequency range [3.2,19.5]GHz. [J1324]

"Maritime border control computer simulation"

This work describes a computer simulator for an integrated command and control (C2) multi-sensor system acting in a maritime border control scenario. The analyzed system is composed of two platforms of multiple sensors: a land-based platform, equipped with a Vessel Traffic System (VTS) radar, an Infrared camera (IR), and an Automatic Identification System (AIS); an airborne platform, carrying an Airborne Early Warning Radar (AEWR) and an IR camera. The mission of the system is the detection, tracking, and identification of multiple naval targets inside a sea region, their threat level evaluation, and the selection of an intervention against possible threat targets, in order to inspect their nature. The Measures of Effectiveness (MoE) of the integrated system are evaluated, i.e., the system performance during the detection, the threat evaluation process, and the intervention. [J1325]

"Distinguished tutorials program"

{no data available} [J1326]

"Development and testing of a 10 GHz phased-array cylindrical-antenna transmitting system incorporating a least-squares radiation-pattern synthesis technique"

This research presents the development and testing procedures for an experimental phased-array cylindrical-antenna transmitting system, operating at 10 GHz. The antenna-element excitation phases are set at the intermediate-frequency stage, and are determined by using a least-squares radiation-pattern synthesis

technique. The antenna-element excitation amplitudes are taken to be equal and fixed. The system provides steerable main lobes and nulls at predefined directions, including control of the sidelobes at specified levels. It can be used for communications and radar applications with interference-rejection requirements. [J1327]

"AMTA Corner"

First Page of the Article [J1328]

"Weighted sum-rate maximization using weighted MMSE for MIMO-BC beamforming design"

This paper studies linear transmit filter design for Weighted Sum-Rate (WSR) maximization in the multiple input multiple output broadcast channel (MIMO-BC). The problem of finding the optimal transmit filter is non-convex and intractable to solve using low complexity methods. Motivated by recent results highlighting the relationship between mutual information and minimum mean square error (MMSE), this paper establishes a relationship between weighted sum-rate and weighted MMSE in the MIMO-BC. The relationship is used to propose two low complexity algorithms for finding a local weighted sum-rate optimum based on alternating optimization. Numerical results studying sum-rate show that the proposed algorithms achieve high performance with few iterations. [J1329]

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{no data available} [J1330]

"Mechanical engineering's role in multi-disciplinary radar design"

Successful execution of a program and full satisfaction of the customer's requirements is a challenge for any contractor. Raytheon Company responds to this challenge by following a proven program execution methodology. The methodology includes all program aspects from financial planning to engineering to validation and test. This discusses the engineering team and the role of the mechanical engineer. A radar system is ultimately an assembly of advanced electronics and software. However, the design, fabrication, assembly, integration, and test Of this complex system requires a coherent multi-disciplinary approach. Raytheon, like many contractors, chooses to assemble an integrated product team (IPT) including all engineering disciplines. Mechanical engineering is integral to satisfying performance requirements, performing preliminary and detailed design, transition of the design to manufacturing, and implementation of the hardware in the field. During definition, mechanical engineering assists fundamental architecture development, conceptual design, and requirements development which precludes issues that are sometimes ignored to the detriment of many programs. These design issues include environmental protection, structural stiffness to meet deflection requirements, cooling system capacity to properly remove dissipated heat, manufacturability to control cost, maintainability to enable repair in the field, and transportability. Recognizing and trading off these issues early greatly increases the Probability Of satisfying customer objectives. This discusses the approach Raytheon is taking to ensure an overall multi-disciplinary solution to our design challenges from the perspective of the mechanical engineer. [J1331]

"Angle estimation using ESPRIT without pairing in MIMO radar"

Recently, it has been shown [Duofang etal.] how the ESPRIT algorithm exploited the invariance property of both the transmit array and the receive array for target direction estimation in a bistatic MIMO radar. However, this method estimates the transmit angles and the receive angles separately in each dimension, and then requires pair matching between the two-dimensional angle estimation, which requires additional computational load. In this reported work, the interrelationship between the two one-dimensional ESPRIT is utilised to obtain automatically paired transmit angles and receive angle estimation without debasing the performance of angle estimation in a bistatic MIMO radar. Simulation results are presented to verify the effectiveness of the proposed method. [J1332]

"Effect of standing stubble on radar backscatter from harvested rice fields"

The radar backscatter from standing rice stubble in a harvested rice field is computed numerically using the method of moments with the equivalence principle and impedance sheet theory. The radar backscatter from a bare surface is also computed based on an empirical model, and combined with the numerical results from the standing rice stubble. Based on the analyses of the radar backscatter for various conditions of standing stubble, it is found that the effect of the standing stubble in a typical harvested rice field is negligible when the water content of the stubble is less than about 40%. [J1333]

"A GB-SAR Processor for Snow Avalanche Identification"

An algorithm for the automatic detection and classification of snow avalanches has been developed and assessed through the archive of synthetic aperture radar (SAR) images acquired during six winter campaigns with a ground-based linear SAR. The scheme, based on the following classic steps: 1) detection; 2) features extraction; and 3) object classification, is fully described in this paper, representing the first attempt to implement a semiautomatic near-real-time operational snow avalanche monitoring tool by SAR. Detection of possible avalanche events is performed by the combined application of thresholding and morphological filters to the differential coherence of consecutive images. Classification of events likely to be snow avalanches is based on statistics extracted from the whole image and features associated to the single regions. Tests have been conducted over more than 60 000 images. Results show a drastic reduction on the images to manually supervise (2.2%). With a 9% false-negative rate and 60% accuracy over the 2.2% of images to examine, the processor represents an interesting support tool for the daily operations of avalanche risk assessment in a commercial ski resort. [J1334]

"The wavenumber algorithm for full-matrix imaging using an ultrasonic array"

Ultrasonic imaging using full-matrix capture, e.g., via the total focusing method (TFM), has been shown to increase angular inspection coverage and improve sensitivity to small defects in nondestructive evaluation. In this paper, we develop a Fourier-domain approach to full-matrix imaging based on the wavenumber algorithm used in synthetic aperture radar and sonar. The extension to the wavenumber algorithm for full-matrix data is described and the performance of the new algorithm compared with the TFM, which we use as a representative benchmark for the time-domain algorithms. The wavenumber algorithm provides a mathematically rigorous solution to the inverse problem for the assumed forward wave propagation model, whereas the TFM employs heuristic delay-and-sum beamforming. Consequently, the wavenumber algorithm has an improved point-spread function and provides better imagery. However, the major advantage of the wavenumber algorithm is its superior computational performance. For large arrays and images, the wavenumber algorithm is several orders of magnitude faster than the TFM. On the other hand, the key advantage of the TFM is its flexibility. The wavenumber algorithm requires a regularly sampled linear array, while the TFM can handle arbitrary imaging geometries. The TFM and the wavenumber algorithm are compared using simulated and experimental data. [J1335]

"Phase-Difference Ambiguity Resolution for a Single-Frequency Signal"

In this letter, we propose a novel method to disambiguate the phase-difference of a single-frequency signal observed between a pair of spatially separated sensors, with inter-sensor spacing exceeding half the wavelength (lambda/2) of the signal. We mathematically prove that, in a noiseless case, the true phase-difference can unambiguously be estimated utilizing a third collinear sensor, provided that the absolute difference between the two smaller inter-sensor spacings is less than lambda/2. The performance of the method is characterized by estimating the probability of failure in noisy cases. [J1336]

"UWB radar for patient monitoring"

During the last few years the Moscow Aviation Institute (Russia) and the Industrial Technology Research Institute (Taiwan) have worked jointly on the development of ultrawideband (UWB) medical radars for remote and contactless monitoring of patients in hospitals. Preliminary results of these works were published in [1]. As of the present, several radars have been produced and tested in real conditions in hospitals in Russia and Taiwan. Some results of these tests are given. [J1337]

"Measurements and inferences of raindrop canting angles"

The canting angle distribution of raindrops derived separately from a 2D video disdrometer and from an S-band advanced polarimetric radar are presented. In the former case, measurements were made in both natural and artificial rain. The canting angles showed a symmetric distribution about 0deg with a standard deviation (sigmabeta) of 7deg-8deg in low wind conditions and 12deg in moderate wind conditions. In the radar-based estimates, the histogram of sigmabetaderived from data obtained during a light stratiform rain event with embedded convection shows the mode to be around 7deg, with a significant positive skewness. Around 16% of occurrences exceeded 10deg and 3.3% exceeded 15deg. [J1338]

"Simultaneous reduction of sidelobes and grating lobes by realising nonlinear synthetic wideband waveforms in SAR processing"

An alternative method of SAR signal processing which can be used to simultaneously reduce sidelobes and

grating lobes of synthetic wideband waveforms (SWW) is proposed. The method applies the super spatially variant apodisation technique to each subpulse image of the SWW, and then cuts appropriate portions of the expanded spectra of the subpulses to effectively realise a nonlinear SWW with much better characteristics. [J1339]

"3-D-Microwave Breast Tumor Detection: Study of System Performance"

This paper presents a study of performance for a 3-D breast tumor detection system. The system is based on processing the scattered signals when a narrow pulse is transmitted from a set of antennas placed surrounding the breast. The 3-D system performance is evaluated by placing the tumor at any breast position, even at locations near the breast muscle where detection is more difficult. Results are obtained for different sizes and positions of the abnormalities that are defined as spherical and bunch-shaped geometries, which approach the well-known breast tumors morphology. These results show that the array distribution considered will have a high impact on detection. [J1340]

"Parallel in-core and out-of-core solution of electrically large problems using the RWG basis functions"

Currently, the problem size that can be solved in reasonable time using the Method of Moments is limited by the amount of memory installed in the computer. This paper offers a new development that not only breaks this memory constraint, but also maintains the efficiency of running the problem in-core. In this paper, highly efficient parallel matrix-filling schemes are presented for parallel in-core and parallel out-of-core integral-equation solvers with subdomain RWG basis functions. The parallel methodology for matrix filling is quite different when using a subdomain basis as opposed to using a higher-order basis. The parallel in-core solver uses memory, which is often expensive and limited in size. The parallel out-of-core solver is introduced to extend the capability of MoM to solve larger problems that can be as large as the amount of storage on the hard disk. Numerical results on several typical computer platforms show that the parallel matrix-filling schemes and matrix-equation solvers introduced here are highly efficient and achieve theoretical predictions. The implementation of these advancements with the widely used RWG basis functions creates a powerful tool for efficient computational electromagnetics solution of complex real-world problems. [J1341]

"Adaptive detection and diversity order in multistatic radar"

We derive the generalized likelihood ratio test (GLRT) for multistatic space-time radar where each sensor platform has a coherent multi-channel array. A multistatic version of the adaptive matched filter (AMF) detector is also developed and its performance results compared with that of the GLRT. Results show that the multistatic GLRT outperforms the multistatic AMF and that the performance advantage increases with the number of radars in the system. The concepts of geometry gain and diversity gain for multistatic STAP are defined in terms of asymptotic properties of the system's probability of miss. [J1342]

"Dispersion Characteristics of a Rectangular Helix Slow-Wave Structure"

A special type of helical slow-wave structure encompassing a rectangular geometry is investigated in this paper, and the slow-wave characteristics are studied taking into account the anisotropically conducting helix. By using the electromagnetic integral equations at the boundaries, the dispersion equation and the interaction impedance of transverse antisymmetric modes in this structure are derived. Moreover, the obtained complex dispersion equation is numerically calculated. The calculation results by our theory agree well with the results obtained by the 3-D EM simulation software HFSS. The numerical results reveal that the phase velocity decreases and interaction impedance increases at higher frequencies by flattening (increasing the aspect ratio of) the rectangular helix structure. In addition, a comparison of slow-wave characteristics of this structure with a conventional round helix is made. [J1343]

"Time-Frequency Analysis for the Localization of Multiple Moving Targets Using Dual-Frequency Radars"

A dual-frequency radar, which estimates the range of a target based on the phase difference between two closely spaced frequencies, has been shown to be a cost-effective approach to accomplish both range-to-motion estimation and tracking. This approach, however, suffers from two drawbacks: it cannot deal with multiple moving targets, and it has poor performance in noisy environments. In this letter, we propose the use of time-frequency signal representations to overcome these drawbacks. The phase, and subsequently the range information, is obtained based on the moving target instantaneous Doppler frequency law, which is provided through time-frequency signal representations. The case of multiple moving targets is handled by separating the different

Doppler signatures prior to phase estimation. [J1344]

"Random Body Movement Cancellation in Doppler Radar Vital Sign Detection"

The complex signal demodulation and the arctangent demodulation are studied for random body movement cancellation in quadrature Doppler radar noncontact vital sign detection. This technique can be used in sleep apnea monitor, lie detector, and baby monitor to eliminate the false alarm caused by random body movement. It is shown that if the dc offset of the baseband signal is accurately calibrated, both demodulation techniques can be used for random body movement cancellation. While the complex signal demodulation is less likely to be affected by a dc offset, the arctangent demodulation has the advantage of eliminating harmonic and intermodulation interference at high carrier frequencies. When the dc offset cannot be accurately calibrated, the complex signal demodulation is more favorable. Ray-tracing model is used to show the effects of constellation deformation and optimum/null detection ambiguity caused by the phase offset due to finite antenna directivity. Experiments have been performed using 4-7 GHz radar to verify the theory. [J1345]

"Institutional listings"

{no data available} [J1346]

"A Fast Robust Chinese Remainder Theorem Based Phase Unwrapping Algorithm"

A robust phase unwrapping based on the Chinese remainder theorem (CRT) has been proposed lately, and it has applications in synthetic aperture radar (SAR) imaging for moving targets. It also leads to a type of robust CRT. This algorithm requires a two-dimensional searching. In this letter, we propose a new and fast algorithm that only does one-dimensional searching and therefore reduces the complexity significantly. [J1347]

"Polar format agorithm using chirp scaling for spotlight SAR image formation"

A novel implementation of the polar format algorithm (PFA) using the principle of chirp scaling (PCS) for spotlight synthetic aperture radar (SAR) image formation is addressed. A PFA completely free of interpolation has been achieved in moderate squinted imaging geometry. The presented approach consists of the range and azimuth scaling of the polar samples, in which only fast Fourier transforms (FFTs) and complex vector multiplications are involved. Following different processing chains, the dechirped and the chirped SAR signals are treated separately in this paper. Relative to the classic polyphase filter that uses the long sinc kernel, the new solution is able to attain a comparable result, but is much quicker by exploiting inherent properties of the linear frequency modulated (LFM) signal. Point target simulation has validated the presented methodology. [J1348]

"Introduction [JPart Two, NASA at 50]"

Introduces the supplement saluting NASA on its fiftieth anniversary. [J1349]

"Post WWII technology [JPart Two, NASA at 50]"

The US space program is a prime example of how a national imperative can reap benefits far beyond its initial goals. The attraction of space had been unfolding for nearly a century in novels; and early experiments with balloons and aircraft stimulated interest across the globe. Advances in rocket propulsion and structures were absolutely vital to accessing outer space; it is unlikely that the space race could have proceeded without these two critical technologies. Although discovered in the late 1 940 s, solid-state electronics remained a curiosity until the military began to use them to reduce the size, weight, and power requirements for their critical systems. [J1350]

"Letter to the Editor"

Development of the GCA Radar Landing System: A Memoir by C.A. Fowler, I was clearing out some packing boxes in the garage and came across an album of photos and memorabilia that my Mother saved from my Army Air Force service in Germany from 1946 to 1948. Included was a Munich Air Base newspaper published in February 1947, showing photos of the Munich GCA and an explanation of the Airways and Air Communications Service (AACS) that included the GCA installation! I have enclosed a photocopy of the newspaper. Would you be kind enough to send this to Mr. Fowler? [We have.-Editors] I entered the Army Air Corps in October 1945 (age 17) and was trained as a Ground Maintenance Mechanic for Airborne and Ground Radio equipment. I served in the AACS from July 1946 to July 1948. In September 1946, I was assigned to Bremerhaven, Germnany Air Base in the AACS Detachment and took care of Control Tower Radios (UHF and Ground-to-Ground (HIP) Air Traffic Control transmitters from September to December 1946. [J1351]

"Upper Bound of Coherent Integration Loss for Symmetrically Distributed Phase Noise"

To evaluate the coherent integration loss caused by the phase noise, an analytic upper bound is proposed in this letter when the phase noise has symmetric distribution. The proposed bound may accurately indicate the possible worst degradation with a maximum integration loss even when the distribution of phase noise is unknown, which is helpful for the evaluation of the negative effects of the phase noise. Furthermore, the specified discrete dual-peak distribution (DPD) is also given to achieve the proposed bound. Finally, some numerical experiments are provided to demonstrate the effectiveness of the proposed bound. [J1352]

"On-board axial detection of wake vortices using a 2-m m LiDAR"

This paper describes the first successful attempt to detect wake vortices axially using an on-board infrared pulsed Doppler LiDAR (light detection and ranging) is described. On-board axial detection is more complex than the classic ground-based tangential approach, because the axial air speed in vortices is low and the atmospheric particle density is reduced, yielding a poorer SNR. To provide meaningful results in such unfavorable conditions we have developed a new flexible signal processing method based on a two-primitive model fitting the spectrum of the Doppler return. This new spectral estimation successfully detects wake vortices with an admissible SNR that is lower than other on-board state-of-the-art approaches. It was validated through flight tests. [J1353]

"Joint detection and tracking of unresolved targets with monopulse radar"

Detection and estimation of multiple unresolved targets with a monopulse radar is a challenging problem. For ideal single bin processing, it was shown in the literature that at most two unresolved targets can be extracted from the complex matched filter output signal. A new algorithm is developed to jointly detect and track more than two unresolved targets from a single detection with the help of tracking information. That is, the method involves the use of tracking information in the detection process. For this purpose, target states are transformed into detection parameter space, which involves high nonlinearities. In order to handle the nonlinearities, the particle filter, which has proven to be effective in nonlinear non-Gaussian estimation problems, is used as the basis of the closed loop system for tracking multiple unresolved targets. In addition to the standard particle filtering steps, the detection parameters corresponding to the predicted particles are evaluated using the nonlinear monopulse radar beam model. This in turn enables the evaluation of the likelihood of the monopulse signal given tracking data. Bayesian model selection is then used to find the correct detection event. The corresponding particle set is taken as the correct representation of the target posterior. A simulated amplitude comparison monopulse radar is used to generate the data and validate the joint detection and tracking of more than two unresolved targets. [J1354]

"Fast Solution of Scattering From Conducting Structures by Local MLFMA Based on Improved Electric Field Integral Equation"

In this paper, a local multilevel fast multipole algorithm (LMLFMA) based on an improved electric field integral equation (IEFIE) is developed to achieve fast and efficient solution of electromagnetic scattering from 3-D conducting structures. The IEFIE is used to reduce iteration number, and LMLFMA is applied to further accelerate the computation of matrix-vector multiplications in iteration, in which only the local interactions between subscatterers are taken into account. Numerical results show that the present method attains faster iterative convergence than traditional EFIE and less computational cost than MLFMA. The speedup can achieve at least 4-5 times while keeping an rms error of less than 2 dB. [J1355]

"Grating lobes suppression in stepped-frequency pulse train"

Frequency stepping is one of the known techniques employed by modern radars to achieve high range resolution. The main advantage of this approach is that the actual instantaneous bandwidth of a radar is quite small compared with the total processing bandwidth. This allows the transmission of waveforms with extremely wide overall bandwidth (and, as a consequence, the attainment of high range resolution) without the usage of the expensive hardware needed to support wide instantaneous bandwidth. Unfortunately, the autocorrelation function of uniform frequency stepped pulse trains can have undesirable peaks, known as "grating lobes." We address this issue, using an approach which allows us to suppress grating lobes below a desired threshold level in the case of appropriately chosen stepped frequency waveforms. We discuss in detail how to choose relevant parameters in order to produce such waveforms with small grating lobes, and give examples of waveforms with small overlap ratio. We also discuss the issue of high sidelobes in the vicinity of the mainlobe, which are inevitable in a stepped frequency train of linear frequency modulated (LFM) waveforms with small overlap ratio, and show that it is possible to suppress these, as well as the grating lobes, by means of nonlinear frequency

modulation (NLFM). [J1356]

"Accuracy and Resolution of ALOS Interferometry: Vector Deformation Maps of the Father's Day Intrusion at Kilauea"

We assess the spatial resolution and phase noise of interferograms made from L-band Advanced Land Observing Satellite (ALOS) synthetic-aperture-radar (SAR) data and compare these results with corresponding C-band measurements from European Space Agency Remote Sensing Satellite (ERS). Based on cross-spectral analysis of phase gradients, we find that the spatial resolution of ALOS interferograms is 1.3times better than ERS interferograms. The phase noise of ALOS (i.e., line-of-sight precision in the 100-5000-m wavelength band) is 1.6times worse than ERS (3.3 mm versus 2.1 mm). In both cases, the largest source of error is tropospheric phase delay. Vector deformation maps associated with the June 17, 2007 (Father's day) intrusion along the east rift zone of the Kilauea Volcano were recovered using just four ALOS SAR images from two look directions. Comparisons with deformation vectors from 19 continuous GPS sites show rms line-of-site precision of 14 mm and rms azimuth precision (flight direction) of 71 mm. This azimuth precision is at least 4times better than the corresponding measurements made at C-band. Phase coherence is high even in heavily vegetated areas in agreement with previous results. This improved coherence combined with similar or better accuracy and resolution suggests that L-band ALOS will outperform C-band ERS in the recovery of slow crustal deformation. [J1357]

"Forest Height Inversion Using High-Resolution P-Band Pol-InSAR Data"

In this paper, a high-resolution P-band Pol-InSAR data set acquired by the airborne RAMSES system over pine forest stands of different height is investigated. A significant penetration depth in all the polarimetric channels and a wide range of polarimetric phase center heights are observed, attesting of an interaction of the radar waves with different forest structural elements. The main objective of this paper concerns forest height inversion at P-band. First, forest-modeling assumptions are evaluated using aprioriinformation, such as ground-level and forest height measurements. The full extend of the forest height is shown to be responsible of the volume decorrelation, and a significant orientation effect is clearly identified over the highest stands. As a consequence, the Oriented Volume over Ground model (OVoG) is determined to be the most appropriated model for the forest height inversion. At P-band, the ground contribution is present in all the polarimetric channels due to the important penetration at this frequency. To overcome this difficulty, a time-frequency optimization method based on sublook decomposition is developed to separate the pure ground and canopy contributions, allowing forest height estimation with OVoG with an rms error on the order of 2 m. In the last section of this paper, a sensitivity analysis of the inversion with respect to two important system parameters, the signal-to-noise ratio and the resolution, is presented, leading to a discussion on the inversion robustness in spaceborne conditions, where these system parameters are the most deteriorated as compared to airborne configurations. [J1358]

"Doppler Ambiguity Resolving in Compressed Azimuth Time and Range Frequency Domain"

For high-quality synthetic aperture radar (SAR) processing, Doppler centroid ambiguity resolving is an essential procedure. A novel method for the resolution of Doppler ambiguity is presented which exploits the fact that, in the compressed azimuth time and range frequency domain, all targets span the same range frequency bandwidth and exhibit the same slope which is just proportional to the Doppler ambiguity number. The slope is removed by interpolation so that a simplified Radon transform can be applied. The use of entropy to find the maximum concentration of the Radon-transformed image can improve the robustness of the method. The proposed method directly gives a reliable estimate of the Doppler ambiguity number and is not affected by the azimuth partially covered targets. Experimental results show that the proposed method works well in medium- to high-contrast scenes. [J1359]

"A C-Band Scatterometer Simultaneous Wind/Rain Retrieval Method"

Using collocated ERS scatterometer (ESCAT), Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR), and European Centre for Medium-Range Weather Forecasts (ECMWF) data, the effects of rain on ESCAT wind-only retrieval are evaluated. Additional scattering from rain causes estimated wind speeds to appear higher than expected. Selected directions of the rain-corrupted wind vectors are biased toward along-track directions under conditions of heavy rain, which is regardless of the true wind direction. Rain becomes more significant for data acquired at a high incidence angle. To compensate for rain-induced backscatter, a simultaneous wind/rain retrieval (SWRR) method, which simultaneously retrieves wind velocity and surface rain rate from ESCAT measurements with an incidence angle >40deg, is developed by using a C-band wind/rain backscatter model. The performance of SWRR under typical wind/rain conditions is evaluated through simulation and validation with collocated TRMM PR and ECMWF data sets. SWRR is shown to significantly improve wind velocity estimates,

and the SWRR estimated surface rain rate has relatively high accuracy in moderate to heavy rain cases. Although SWRR-retrieved rain is somewhat biased, it can be corrected. We note that for ESCAT, about 1.5% of all the collocated measurements is affected by significant rain. [J1360]

"Sea-Surface Polarization Ratio From Envisat ASAR AP Data"

The polarization ratio (VV/HH) of normalized radar cross section over ocean surface is processed from Envisat Advanced Synthetic Aperture Radar (ASAR) alternating polarization (AP) data and compared with existing electromagnetic (EM) scattering models. The processing of the AP data is based on Level0 (raw data) product that enables us to accurately compute the contribution from additive noise separately from each burst. This is important in estimating the correct polarization ratio, particularly at higher incidence angles where the relative contribution from noise becomes severe. A recently published EM scattering model, general curvature method (GCM), is extended here to incorporate scattering from breaking waves. The performance of this model with and without breaking waves is compared with AP data and with other models for the polarization ratio. The extended GCM model is furthermore used to assess the performance of wind speed retrieval in HH polarization. The inclusion of wave breaking in the GCM model reduces the polarization ratio standard deviation from 0.64 to 0.50 and the bias from -0.34 to 0.16, as compared to the measured ASAR AP polarization ratio. The best semiempirical model from literature gives 0.51 and 0.63 for the standard deviation and bias, respectively. The difference in performance is shown to be caused by the wind speed dependence not accounted for in the semiempirical model. Validation of the new polarization ratio model in combination with C-band Model Function (CMOD) for wind speed retrieval at HH polarization shows similar performance as at VV polarization. We conclude that the GCM polarization ratio model incorporating wave-breaking effects is found to reproduce well polarization ratio measurements (ASAR AP) versus wind vector and incidence angle. [J1361]

"Parametric Velocity Synthetic Aperture Radar: Multilook Processing and Its Applications"

Based on a parametric model and some optimum methods, it has been previously proved that parametric velocity synthetic aperture radar (VSAR) may improve the performances of moving target detection and parameter estimation simultaneously. In this paper, multilook processing is studied for parametric VSAR. At first, statistical signal models are established for azimuth multilook processing (AMLP) and range multilook processing (RMLP), respectively. By combining the multiple AMLP sublook pixel vectors, it is shown that the clutter parameter estimation accuracy can be further improved via the maximum-likelihood estimation methods. Meanwhile, based on the adaptive implementation for the optimum processing of VSAR, RMLP can be used to improve slowly moving target detection performance via the noncoherent integration of multiple range sublooks. Furthermore, it is shown that the Doppler frequencies of moving targets vary linearly with different range sublooks due to the different carrier frequencies of sublooks. Therefore, based on a proposed novel two-step multilook diversity (TS-MLD) estimator for RMLP, the "azimuth location ambiguity" of VSAR can be well resolved via least squares linear regression, without configuration change of the conventional VSAR. Also, the estimation accuracy of target's unambiguous Doppler frequency, as well as target's azimuth location, is derived for the proposed TS-MLD method. Finally, numerical experiments and scene simulations are provided to demonstrate the effectiveness of the proposed multilook-based methods. [J1362]

"Inversion of Spaceborne X-Band Synthetic Aperture Radar Measurements for Precipitation Remote Sensing Over Land"

Several spaceborne X-band synthetic aperture radar (X-SAR) systems were launched in 2007, and more will be launched in the current decade. These sensors may significantly augment the sensors that comprise the global precipitation mission (GPM) constellation. X-SAR rainfall measurements may be beneficial particularly over land where rainfall is difficult to measure by means of satellite microwave radiometers. Inversion techniques to quantitatively derive precipitation fields over land at high spatial resolution are developed and illustrated in this paper. These inversion algorithms are the model-oriented statistical (MOS) methodology and the Volterra integral equation (VIE) approach. Simplified rain-cloud models are used to train and test the inversion algorithms by evaluating the expected error budget. Two case studies, using data obtained from measurements of SIR-C/X-SAR in 1994 over Bangladesh and the Amazon, are introduced, and retrieved precipitation maps are discussed. Even though no validation of the precipitation estimates was possible, the obtained results are encouraging, showing physically consistent retrieved structures and patterns. [J1363]

"A Numerical Method for Studying Modulation Effects in Radar Observations of the Sea Surface"

A numerical method for performing detailed investigations of modulation effects in sea backscattering is presented. The method is based on a combination of numerical hydrodynamic and electromagnetic codes as well as repeated simulations as the spectral content of the sea surface is varied. The results obtained can be useful

in separating ldquotiltrdquo and hydrodynamic modulations in computed sea backscattering cross sections, and help to provide some insight into the need for ldquothree-scalerdquo modeling of sea surface returns. Sample results are presented to illustrate the basic process. [J1364]

"Comments on "A Linear Closed-Form Algorithm for Source Localization From Time-Differences of Arrival""

In a recent letter by Gillette and Silverman, a linear closed-form algorithm (the GS algorithm) for source localization from time-differences of arrival is proposed. It is claimed that ldquoit is so simple that we were surprised that, until very recently, there have been no other solutions similar to ours.rdquo This comment has two objectives. We point out imprecisions of statement, and we give additional references of closely related works, some of them presenting the same results. [J1365]

"Interpretation of Multisensor Remote Sensing Images: Multiapproach Fusion of Uncertain Information"

Land cover interpretation using multisensor remote sensing images is an important task that allows the extraction of information that is useful for several applications. However, satellite images are usually characterized by several types of imperfection, such as uncertainty, imprecision, and ignorance. Using additional sensors can help improve the image interpretation process and decrease the associated imperfections. Fusion methods such as the probability, possibility, and evidence methods can be used to combine information coming from these sensors. An extensive literature has accumulated during the last decade to resolve the issue of choosing the best fusion method, particularly for satellite images. In this paper, we present a semiautomatic approach based on case-based reasoning (CBR) and rule-based reasoning, allowing intelligent fusion method retrieval. This approach takes into account the advantage of data stored in the case base, allowing a more efficient processing and a decrease in image imperfections. The proposed approach incorporates three modules. The first is a learning module based on evaluating three fusion methods (probability, possibility, and evidence) applied to the given satellite images. The second looks for the best fusion method using CBR. The last is devoted to the fusion of multisensor images using the method retrieved by CBR. We validate our approach on a set of optical images coming from the Satellite Pour l'Observation de la Terre 4 and radar images coming from European Remote Sensing Satellite 2 (ERS-2) representing a central Tunisian region. [J1366]

"Multiapproach System Based on Fusion of Multispectral Images for Land-Cover Classification"

Satellite image classification is usually marked by several types of imperfection such as uncertainty, imprecision, and ignorance. Data fusion of additional sensors tries to overcome the types of imperfection by using probability, possibility, and evidence theories. Our approach will lead to improve classification accuracy of satellite images by choosing the optimum theory for a particular image context and proposing a theoretical framework based on a multiagent system and case-based reasoning. We validate our approach trough a set of optical images from the satellite Satellite Positioning and Tracking 4 and radar images from the European Remote Sensing satellite 2, and we show that the overall accuracy is considerably increased from 83% for maximum-likelihood classification applied to multispectral imagery to 94% with the proposed approach. [J1367]

"An Imaging HF GPR Using Stationary Antennas: Experimental Validation Over the Antarctic Ice Sheet"

Terrestrial And Planetary Imaging Radar (TAPIR) is an innovative high-frequency ground-penetrating radar (GPR) developed in the frame of the Martian NetLander mission to probe the subsurface down to kilometric depths. Unlike most GPRs, TAPIR is able to image underground reflectors with stationary antennas. In this paper, after a brief presentation of the instrument, we describe the method developed to interpret data collected during the RAdar of NEtlander in Terre Ade acutelie (RANETA) field survey in Antarctica. This method consists of retrieving the direction of arrival of each detected echo through the measurement of five components of the electromagnetic field (the three magnetic components and the horizontal components of the electric field). Thus, both the range and the direction of each individual reflection or diffraction due to the ice-bedrock interface are resolved. We validated this method on finite-difference time-domain numerically simulated data for different subsurface configurations before applying it to RANETA observations. In particular, the irregular topography of the bedrock in two sounding sites was revealed. We discuss the accuracy of our results. [J1368]

"Improved Space-Based Moving Target Indication via Alternate Transmission and Receiver Switching"

Ground moving target indication (GMTI) by space-based radar systems requires special antenna and data

acquisition concepts to overcome the problem of discriminating target signals from clutter returns. Owing to the high satellite speed, the clutter contains a broad mixture of radial velocities within the antenna beam, leading to a large Doppler spread. Effective clutter suppression can solely be achieved by multiple aperture or phase center antennas. For space-based systems, however, the number of receiver channels connected to subapertures is very limited due to their weight, volume, and high data rates (current systems such as TerraSAR-X and RADARSAT-2 possess only two). This classical along-track interferometry architecture, in which the antenna is split into two halves, achieves only suboptimum GMTI performance. This paper presents and statistically analyzes an innovative approach to create additional independent phase centers to improve the GMTI performance considerably. The extra degrees of freedom are created by cyclical phase and amplitude switchings of the transmit/receive modules for transmitter and receiver between pulses, hence trading Doppler bandwidth for extra spatial diversity. In the first part of this paper, different strategies of spatial-temporal diversity are introduced and analyzed for realistic system parameters with respect to ambiguities and detection performance. The second part is concerned with the elaborate theoretical analysis of the relocation improvement for the spatial diversity approach. [J1369]

"Algorithm to Retrieve Aerosol Optical Properties From High-Spectral-Resolution Lidar and Polarization Mie-Scattering Lidar Measurements"

We developed an algorithm to estimate the vertical profiles of extinction coefficients at 532 nm for three aerosol types that are water-soluble, soot, and dust particles, using the extinction and backscattering coefficients at 532 nm for total aerosols derived from high-spectral-resolution lidar (HSRL) measurements and the receiving signal at 1064 nm and total depolarization ratio at 532 nm measured with Mie scattering lidar (MSL). The mode radii, standard deviations, and refractive indexes for each aerosol component are prescribed by the optical properties of aerosols and clouds database; the optical properties for each aerosol component are computed from Mie theory on the assumption that their particles are spherical and homogeneous, except for dust. To consider the effect of nonsphericity, the dust lidar ratio at 532 nm is assumed to be 50 sr, the value that is reported for Asian dust from the other observational studies. We performed sensitivity study on retrieval errors. The errors in extinction coefficient for each aerosol component were smaller than 30% and 60% when the measurement errors were plusmn5% and plusmn 10%. We demonstrated the ability of the algorithm by applying to the HSRL + MSL data measured at Tsukuba, Japan. Plumes consisting of water-soluble aerosols, soot, dust, or their mixture were retrieved; these results were consistent with simulation with a global aerosol transport model. Introducing the dust lidar ratio significantly improved a correlation between the retrieved dust concentration and the aerosol depolarization ratio at 532 nm derived from HSRL + MSL than the use of spherical dust optical model in the retrieval. [J1370]

"Characterizing Bidimensional Roughness of Agricultural Soil Surfaces for SAR Modeling"

In the description of agricultural soil roughness, the hypothesis of surface isotropy is currently admitted, and linear measurements are often used to characterize the soil roughness considered as a single-scale process. However, multiscale roughness is frequently observed, and tillage practices created oriented roughness. This paper presents a new technique to measure precisely the bidimensional soil roughness. Digital elevation model derived using photogrammetric technique reproduces the millimeter-scale height variations of three different soil surfaces (ploughed, smoothed, and row structured field) over about 8 m2. A single surface measurement is sufficient to accurately measure the soil roughness parameters. Geostatistic parameterization allows the measurement of the roughness anisotropy. For smooth surface, a two-scale roughness is observed. Anisotropy is observed in the larger scale roughness. The proposed method allows the computation of the bidimensional correlation function, which is required by the integral equation method model for the simulation of the SAR signal over anisotropic soil surfaces. [J1371]

"Scatterometer-Derived Soil Moisture Calibrated for Soil Texture With a One-Dimensional Water-Flow Model"

Current global satellite scatterometer-based soil moisture retrieval algorithms do not take soil characteristics into account. In this paper, the characteristic time length of the soil water index has been calibrated for ten sampling frequencies and for different soil conductivity associated with 12 soil texture classes. The calibration experiment was independently performed from satellite observations. The reference soil moisture data set was created with a 1-D water-flow model and by making use of precipitation measurements. The soil water index was simulated by applying the algorithm to the modeled soil moisture of the upper few centimeters. The resulting optimized characteristic time lengths Tincrease with longer sampling periods. For instance, a Tof 7 days was found for sandy soil when a sampling period of 1 day was applied, whereas an optimized T-value of 18 days was found for a sampling period of 10 days. A maximum rmse improvement of 0.5% vol. can be expected when using the calibrated T-values instead of T= 20. The soil water index and the differentiated T-values were applied to

European Remote Sensing (ERS) satellite scatterometer data and were validated against insitusoil moisture measurements. The results obtained using calibrated T-values and T= 20 did not differ (r= 0.39, rmse = 5.4% vol.) and can be explained by the averaged sampling period of 4-5 days. The soil water index obtained with current operational microwave sensors [Advanced Wind Scatterometer (ASCAT) and Advanced Microwave Scanning Radiometer-Earth Observation System] and future sensors (Soil Moisture and Ocean Salinity and Soil Moisture Active Passive) should benefit from soil texture differentiation, as they can record on a daily basis either individually or synergistically using several sensors. The proposed differentiated characteristic time length enables the continuation of the soil water index of sen--sors with varying sampling periods (e.g., ERS-ASCAT). [J1372]

"Infrared Thermography for Buried Landmine Detection: Inverse Problem Setting"

This paper deals with an inverse problem arising in infrared (IR) thermography for buried landmine detection. It is aimed at using a thermal model and measured IR images to detect the presence of buried objects and characterize them in terms of thermal and geometrical properties. The inverse problem is mathematically stated as an optimization one using the well-known least-square approach. The main difficulty in solving this problem comes from the fact that it is severely ill posed due to lack of information in measured data. A two-step algorithm is proposed for solving it. The performance of the algorithm is illustrated using some simulated and real experimental data. The sensitivity of the proposed algorithm to various factors is analyzed. A data processing chain including anomaly detection and characterization is also introduced and discussed. [J1373]

"Adaptive pulse compression of MIMO radar based on GSC"

Adaptive pulse compression (APC) is an effective method for mitigating the mutual interference of the multiple waveforms transmitted in multiple-input multiple-output (MIMO) radar. But APC based on minimum mean-square error (MMSE) is computationally inefficient. Therefore, APC of MIMO radar based on a generalised sidelobe canceller (GSC) is proposed, which can effectively reduce the complexity. Numerical experiments show that the proposed method is superior to the matched filter (MF), and performs similarly as APC based on MMSE. [J1374]

"Update: Magnetic Field Sensors Could Help Halt Runway Crashes"

Air-traffic control is a complex and high-stress business. Mistakes are not allowed. And it's not limited to directing planes for takeoff and landing-a job that's been memorably described as three-dimensional chess. It also includes keeping track of where planes are on the ground. According to safety watchdog Eurocontrol, in 2005 alone there were 600 occasions when people, cars, or planes crossed Europe's airport taxiways when they shouldn't have. In fact, the most deadly airline accident ever happened on the ground: in 1977, two 747 jumbo jets collided in the Canary Islands, killing 583 people. Most big airports have expensive ground-radar systems to keep track of where the hundreds of moving planes are on the sprawling tarmacs. But ground radar sometimes reflects off buildings and terminals, leaving small gaps in coverage. Smaller airports like the one in Thessaloniki, Greece, can't afford ground radar. Such blind spots on the ground at airports large and small have prompted European researchers to explore the use of fluctuations in the Earth's magnetic field to better pinpoint where planes are on busy taxiways. The results, researchers say, show that using US $150 sensors can fill in the blind spots. [J1375]

"Chaos-Based Radars for Automotive Applications: Theoretical Issues and Numerical Simulation"

This correspondence focuses on a possible application of chaotic signals as an alternative to more conventional spreading schemes in direct-sequence spread spectrum (DS-SS) automotive radars, the latter being a key component for future road safety systems. Due to their very good correlation properties, chaotic sequences are potentially able to outperform previous options, like Gold codes, with regard to the detection probability and the number of available sequences. Numerical examples are given, in some typical scenarios and under severe operation conditions, due to the presence of interfering radars. [J1376]

"Update: Carbon-Nanotube Wiring Gets Real"

Could carbon nanotubes have a shot at replacing the copper wires that connect millions of transistors on today's silicon chips? Chip makers replaced aluminum interconnects with better conducting copper ones about seven years ago, but now copper's days are numbered too. Higher- performance chips with more- tightly packed transistors, expected as soon as 2012, will need interconnects less than 40 nanometers wide, at which point copper's resistance will slow signaling down too much. Late last month, at the Materials Research Society's spring meeting in San Francisco, a team of engineers from Stanford and Toshiba reported that they have used carbon nanotubes to wire logic-circuit components on a conventional silicon CMOS chip. They claim to have shown that nanotubes can shuttle data at speeds of a little faster than 1 gigahertz, close to the range of state-of-

the-art microprocessors, which run at speeds of 2 to 3 GHz. [J1377]

"Estimation and Optimal Configurations for Localization Using Cooperative UAVs"

The time-difference of arrival techniques are adapted to locate networked enemy radars using a cooperative team of unmanned aerial vehicles. The team is engaged in deceiving the radars, which limits where they can fly and requires accurate radar positions to be known. Two time-differences of radar pulse arrivals at two vehicle pairs are used to localize one of the radars. An explicit solution for the radar position in polar coordinates is developed. The solution is first used for position estimation given ldquonoisyrdquo measurements, which shows that the vehicle trajectories significantly affect estimation accuracy. Analyzing the explicit solution leads to the angle rule, which gives the optimal vehicle configuration for the angleestimate. Analyzing the fisher Information matrix leads to the coordinate rule, which gives a different optimal configuration for the positionestimate. A linearized time-varying model is also formulated and an extended Kalman filter applied. This estimation scheme is compared with the earlier one, with the second showing overall improvement in reducing the variance of the estimate. [J1378]

"Careers: So You Want To Be An Expert Witness"

Roger L. Boyell says forensic engineering is a great job-if you can take the pressure.He's part of a growing cadre of engineers who are trading steady paychecks and corporate environments for the often solitary and occasionally adrenaline- inducing position of expert witness. It's their job to evaluate engineering systems, products, and devices and explain them in layman's terms in a courtroom. [J1379]

"Urban Mapping Using Coarse SAR and Optical Data: Outcome of the 2007 GRSS Data Fusion Contest"

The 2007 data fusion contest that was organized by the IEEE Geoscience and Remote Sensing Data Fusion Technical Committee was dealing with the extraction of a land use/land cover maps in and around an urban area, exploiting multitemporal and multisource coarse-resolution data sets. In particular, synthetic aperture radar and optical data from satellite sensors were considered. Excellent indicators for mapping accuracy were obtained by the top teams. The best algorithm is based on a neural classification enhanced by preprocessing and postprocessing steps. [J1380]

"Mismatched Filtering of Aperiodic Quadriphase Codes"

Matched filtering of quadriphase coded radar signals creates unwanted sidelobes, which may mask important information. This correspondence presents a method of eliminating these sidelobes in aperiodic quadriphase codes. This is done by using a mismatched filter. The signal-to-noise ratio (SNR) at the output of the mismatched filter is less than the SNR at the output of the corresponding matched filter. A thorough computer search has been carried out to find quadriphase code-mismatched filter pairs with minimum possible SNR losses by considering a point target in the presence of white Gaussian noise. The phase patterns of the optimal codes, which were chosen from a total number of 1.466 times 1012investigated codes, are shown. It turned out that the mismatched filter of a quadriphase Barker code with 15 elements (1, 1, 1, j, j, 1,-j,-j, j, -1,-j, j, 1, -1, 1) has a loss in SNR of only 6.7% when compared with the corresponding matched filter. The mismatched filter of the well known 13-element Barker code, which has a loss in SNR of 4.8%, outperforms this filter. Finally, using numerical experiment it is shown that a randomly selected long code will most likely have very large SNR losses. [J1381]

"An Investigation of Using the Spectral Characteristics From Ground Penetrating Radar for Landmine/Clutter Discrimination"

Ground penetrating radar (GPR)-based discrimination of landmines from clutter is known to be challenging due to the wide variability of possible clutter (e.g., rocks, roots, and general soil heterogeneity). This paper discusses the use of GPR frequency-domain spectral features to improve the detection of weak-scattering plastic mines and to reduce the number of false alarms resulting from clutter. The motivation for this approach comes from the fact that landmine targets and clutter objects often have different shapes and/or composition, yielding different energy density spectrum (EDS) that may be exploited for their discrimination (this information is also present in time-domain data, but in the frequency domain we can remove a phase if desired and can reveal better spatial characteristics and therefore often achieve greater robustness). This paper first applies the finite-difference time-domain (FDTD) modeling technique to establish the theoretical foundation. The method to generate EDS from GPR measurements is then described. The consistency of the frequency-domain features is examined through two different GPRs that have different spatial sampling rates and frequency bandwidths. Experimental results

from several test sites, based on GPR data collected over buried mines and emplaced buried clutter objects, corroborate the theoretical development and the effectiveness of the proposed spectral feature to increase the accuracy of landmine detection and discrimination. [J1382]

"Lateral Current Confinement Determines Silicon Avalanche Transistor Operation in Short-Pulsing Mode"

The transient in a Si bipolar junction transistor was investigated in high-current short-pulsing (2 ns) mode both experimentally and numerically. A comparison of measured and simulated waveforms clearly showed that only a small fraction of the perimeter of the emitter-base interface (in the lateral direction) takes part in the switching transient when a capacitor of relatively small value (80 pF) is discharged across the transistor to obtain a current pulse of a few nanoseconds in duration. A good agreement was found between measurements and simulations in the 2-D numerical model when the effective operating perimeter was used as a parameter in the model. The results allowed reliable analyses of the thermal regime to be performed. Possible reasons for the significant current confinement in short-pulsing mode and relatively homogeneous transistor switching with longer current pulses are discussed, and a mechanism of fast lateral turn-on spread is assumed. One conclusion of practical importance is that a short-pulsing relatively high-current mode could not be realized without current confinement in the lateral direction. [J1383]

"Calibration and Validation of DMSP SSMIS Lower Atmospheric Sounding Channels"

The Special Sensor Microwave Imager Sounder (SSMIS), a new type of conically scanning microwave sounder, was launched by the Defense Meteorological Satellite Program in October 2003. Performance of the instrument and retrieval software was characterized in an extensive calibration/validation campaign. This paper describes results based on comparisons between SSMIS Lower Atmospheric Sounding (LAS) channel measurements and radiative transfer calculations based on conventional synoptic radiosondes, numerical weather prediction models, and special observations campaigns including dedicated lidar measurements and scientific radiosonde and dropsonde measurements. Retrieved lower atmospheric profiles were also directly compared with these data sources. Two significant sources of bias were identified. The emissivity of the primary reflector contributes to measured brightness temperatures, and the warm load calibration source is susceptible to uncompensated solar heating. Otherwise, it was determined that LAS channels are locally stable and accurately track atmospheric changes. Polarization of some channels was found to differ from the design. Several approaches were identified to mitigate sources of bias. [J1384]

"Tumor Response Estimation in Radar-Based Microwave Breast Cancer Detection"

Radar-based microwave imaging techniques have been proposed for early stage breast cancer detection. A considerable challenge for the successful implementation of these techniques is the reduction of clutter, or components of the signal originating from objects other than the tumor. In particular, the reduction of clutter from the late-time scattered fields is required in order to detect small (subcentimeter diameter) tumors. In this paper, a method to estimate the tumor response contained in the late-time scattered fields is presented. The method uses a parametric function to model the tumor response. A maximum aposterioriestimation approach is used to evaluate the optimal values for the estimates of the parameters. A pattern classification technique is then used to validate the estimation. The ability of the algorithm to estimate a tumor response is demonstrated by using both experimental and simulated data obtained with a tissue sensing adaptive radar system. [J1385]

"Classifying Multilevel Imagery From SAR and Optical Sensors by Decision Fusion"

A strategy for the joint classification of multiple segmentation levels from multisensor imagery is introduced by using synthetic aperture radar and optical data. At first, the two data sets are separately segmented, creating independent aggregation levels at different scales. Each individual level from the two sensors is then preclassified by a support vector machine (SVM). The original outputs of each SVM, i.e., images showing the distances of the pixels to the hyperplane fitted by the SVM, are used in a decision fusion to determine the final classes. The fusion strategy is based on the application of an additional classifier, which is applied on the preclassification results. Both a second SVM and random forests (RF) were tested for the decision fusion. The results are compared with SVM and RF applied to the full data set without preclassification. Both the integration of multilevel information and the use of multisensor imagery increase the overall accuracy. It is shown that the classification of multilevel-multisource data sets with SVM and RF is feasible and does not require a definition of ideal aggregation levels. The proposed decision fusion approach that applies RF to the preclassification outperforms all other approaches. [J1386]

"Polarimetric Characterization of Bistatic Coherent Mechanisms"

This paper proposes a generalization of the Huynen theory to bistatic radar configurations for which the scattering matrices can no longer be assumed symmetrical. A set of parameters characterizing the physical mechanisms is extracted from the disoriented bistatic Kennaugh matrix. The distribution of amplitude between the parameters of the disoriented Kennaugh matrix is studied. [J1387]

"Spectrum sensing in cognitive radio networks: requirements, challenges and design trade-offs"

Opportunistic unlicensed access to the (temporarily) unused frequency bands across the licensed radio spectrum is currently being investigated as a means to increase the efficiency of spectrum usage. Such opportunistic access calls for implementation of safeguards so that ongoing licensed operations are not compromised. Among different candidates, sensing-based access, where the unlicensed users transmit if they sense the licensed band to be free, is particularly appealing due to its low deployment cost and its compatibility with the legacy licensed systems. The ability to reliably and autonomously identify unused frequency bands is envisaged as one of the main functionalities of cognitive radios. In this article we provide an overview of the regulatory requirements and major challenges associated with the practical implementation of spectrum sensing functionality in cognitive radio systems. Furthermore, we outline different design trade-offs that have to be made in order to enhance various aspects of the system's performance. [J1388]

"Performance Analysis of Covariance Matrix Estimates in Impulsive Noise"

This paper deals with covariance matrix estimates in impulsive noise environments. Physical models based on compound noise modeling [spherically invariant random vectors (SIRV), compound Gaussian processes] allow to correctly describe reality (e.g., range power variations or clutter transitions areas in radar problems). However, these models depend on several unknown parameters (covariance matrix, statistical distribution of the texture, disturbance parameters) that have to be estimated. Based on these noise models, this paper presents a complete analysis of the main covariance matrix estimates used in the literature. Four estimates are studied: the well-known sample covariance matrix MSCMand a normalized version MN, the fixed-point (FP) estimate MFP, and a theoretical benchmark MTFP. Among these estimates, the only one of practical interest in impulsive noise is the FP. The three others, which could be used in a Gaussian context, are, in this paper, only of academic interest, i.e., for comparison with the FP. A statistical study of these estimates is performed through bias analysis, consistency, and asymptotic distribution. This study allows to compare the performance of the estimates and to establish simple relationships between them. Finally, theoretical results are emphasized by several simulations corresponding to real situations. [J1389]

"Nanosecond Timescale Thermal Dynamics of AlGaN/GaN Electronic Devices"

Time-resolved Raman thermography, with a temporal resolution of, was used to study the thermal dynamics of AlGaN/GaN electronic devices (high-electron mobility transistors and ungated devices). Heat diffusion from the device active region into the substrate and within the devices was studied. Delays in the thermal response with respect to the electrical pulse were determined at different locations in the devices. Quasi-adiabatic heating of the AlGaN/GaN devices is illustrated within the first of device operation. The temperature of devices on SiC was found to reach of the dc temperature when operated with -long electrical pulses. [J1390]

"Conditional Copulas for Change Detection in Heterogeneous Remote Sensing Images"

A new preprocessing technique is presented in this paper to automatically highlight changes in multitemporal strongly heterogeneous remotely sensed images. The proposed technique is devoted to the case where the two acquisitions, before and after a given event, are significantly different, due, for instance, to different sensors, acquisition modalities, or climatic conditions. In a previous study, it was proven that the local statistics of the images acquired at the two dates could be used to extract a relevant change indicator. Nevertheless, this measure is valid when the two observations have been derived from similar acquisitions. When the acquisition modalities differ, local statistics tend to be too different from one image to the other one to be relevant in highlighting the ground evolution without mixing with the changes at ground. The technique proposed in this paper to overcome this limitation is based on the assumption that some dependence indeed exists between the two images in unchanged areas. This dependence is modeled by quantile regression applied according to the copula theory and used to perform an estimation of the local statistics that would have been observed if the acquisition conditions of the first image had been similar to the ones of the second image. The method yields an estimate of the local statistics of the first image through the point of view of the second one. Then, usual Kullback-Leibler-based comparisons of those statistics are applied to define a change measure, which may be analyzed (e.g., by thresholding) in order to detect changes. Experimental results are shown to validate the proposed method by using a pair of Synthetic Aperture Radar (SAR) images onboard European Remote Sensing (ERS) Satellite images and a pair of optical-SAR images (from the High Resolution Visible (HRV) sensor

onboard Satellite Pour l'Observation de la Terre (SPOT) satellite and from ERS-SAR) acquired before and after a flood. [J1391]

"Construction of Optimal Mismatched Periodic Sequence Sets With Zero Correlation Zone"

In mobile communications, navigation, and radar applications, good periodic binary sequences are normally used with matched-filter technique. However, from the viewpoint of signal processing, there is no need to only consider the filter coefficients as binary. This letter presents a theoretical bound for real-valued mismatched sequence sets with zero correlation zone (ZCZ) and then proposes a method for constructing sets of optimal mismatched ZCZ sequences with respect to the theoretical bound for application in mismatched filtering. [J1392]

"Generalized Pairwise Z-Complementary Codes"

An approach to generate generalized pairwise Z-complementary (GPZ) codes, which works in pairs in order to offer a zero correlation zone (ZCZ) in the vicinity of zero phase shift and fit extremely well in power efficient quadrature carrier modems, is introduced in this letter. Each GPZ code has MK sequences, each of length 4NK, where M is the number of Z-complementary mates, K is a factor to perform Walsh-Hadamard expansions, and N is the sequence length of the Z-complementary code. The proposed GPZ codes include the generalized pairwise complementary (GPC) codes as special cases. [J1393]

"Uncorrelated Discriminant Locality Preserving Projections"

In this letter, a new manifold learning algorithm, called uncorrelated discriminant locality preserving projections (UDLPP), is proposed. The aim of UDLPP is to preserve the within-class geometric structure, while maximizing the between-class distance. By introducing a simple uncorrelated constraint into the objective function, we show that the extracted features via UDLPP are statistically uncorrelated, which is desirable for many pattern analysis applications. Moreover, UDLPP can be performed in reproducing kernel Hilbert space, which gives rise to kernel UDLPP. Experimental results on both face recognition and radar target recognition demonstrate the effectiveness of the proposed algorithm. [J1394]

"Data-Level Fusion of Multilook Inverse Synthetic Aperture Radar Images"

Although techniques for resolution enhancement in single-aspect radar imaging have made rapid progress in recent years, it does not necessarily imply that such enhanced images will improve target identification or recognition. However, when multiple looks of the same target from different aspects are obtained, the available knowledge increases, allowing more useful target information to be extracted. Physics-based image fusion techniques can be developed by processing the raw data collected from multiple inverse synthetic aperture radar sensors, even if these individual images are at different resolutions. We derive an appropriate data fusion rule to generate a composite image containing enhanced target shape characteristics for improved target recognition. The rule maps multiple data sets collected by multiple radars with different system parameters on to the same spatial-frequency space. The composite image can be reconstructed using the inverse 2-D Fourier transform over the separated multiple integration areas. An algorithm called the Matrix Fourier Transform is proposed to realize such a complicated integral. This algorithm can be regarded as an exact interpolation such that there is no information loss caused by data fusion. The rotation centers need to be carefully selected to properly register the multiple images before performing the fusion. A comparison of the image attribute rating curve between the fused image and the spatially averaged images quantifies the improvement in the detected target features. The technique shows considerable improvement over a simple spatial averaging algorithm and thereby enhances target recognition. [J1395]

"Estimation of Radial Velocity of Moving Targets by Along-Track Interferometric SAR Systems"

Along-track interferometric synthetic aperture radar (AT-InSAR) can be used to estimate the radial velocity of ground moving targets, starting from interferometric phase measures. The estimation obtained from a single-phase interferogram suffers from ambiguities. To solve these problems, multichannel AT-InSAR systems are required. In this letter, we analyze the radial velocity maximum-likelihood estimation accuracy with respect to AT-InSAR system parameters, such as velocity values and different clutter and thermal noise levels. We consider two different models for the target response: a deterministic model and a zero-mean Gaussian model. The presented results show that AT-InSAR systems exhibit better estimation accuracies for low-velocity values (slow targets). [J1396]

"Response to “Corrections to ‘Calibration of Linearly Polarized Polarimetric SAR Data Subject to Faraday Rotation’” [Jorig. paper Aug 04 1617-1624]"

Provides a response to the corrections submitted (vol. 46, no. 4, p. 1278, Apr 08) to the original article. [J1397]

"Accuracy of the -Distribution Regression Model for Forest Biomass Estimation by High-Resolution Polarimetric SAR: Comparison of Model Estimation and Field Data"

In our previous regression model for estimating forest biomass, it was shown that non-Gaussian amplitude fluctuations in high-resolution polarimetric synthetic aperture radar (SAR) data of coniferous forests can accurately be described by the -distribution and that the order parameter of the -distribution can be useful in estimating the tree biomass of coniferous forests from L-band cross-polarization amplitude images in a wider range than the conventional method using the radar cross section alone. The result was based on the analysis of the ldquoground-truthrdquo biomass data of 19 forest stands and airborne polarimetric interferometric SAR L-band data over the Tomakomai forests in Hokkaido, Japan. From this relation, an empirical regression model was developed to estimate forest biomass from SAR data. In this paper, we report the results on further analyses of this regression model. The validity of the -distribution is first reconfirmed using the Akaike information criterion, followed by the description on the accuracy of the model. To examine model accuracy, we carried out further field measurements on 22 forest stands in 2005, and the ground survey was made in 2006 to find out the causes of several anomalous data. Based on a comparison of the model-based biomass and the ground-truth data, the accuracy of the model was found to be approximately 86%. The regression model was then updated for practical application in estimating the biomass of the Hokkaido forests by including the ground-truth data of all 41 forest stands. [J1398]

"Autofocus for ISAR Imaging Using Higher Order Statistics"

Autofocus is imperative for inverse synthetic aperture radar (ISAR) imaging. In this letter, a new approach for ISAR autofocus is developed by using fourth-order statistics properties of the radarpsilas return signal. After the ISAR signal model is established, the approach is described. The results of processing real data confirm the effectiveness of the proposed approach and show its capability for suppressing noise. The developed approach has a numerical stability and a smaller computational load compared with the maximum image contrast and the minimum image entropy methods. [J1399]

"Likelihood ratio test-based interval estimate of the number of signals present in a measurement"

A multi-step procedure is proposed to construct a confidence interval for the number of signals present and a comparative analysis of our procedure with other existing procedures is conducted. The proposed procedure uses likelihood ratio statistics and its simulated percentiles sequentially to determine the upper and lower limits for the confidence interval. A preference zone in the parameter space of the population eigenvalues is denned and it is used to separate the signals and the noise. The least favourable configuration (LFC) is derived asymptotically under the preference zone. Under the LFC, the procedure parameters necessary to attain the required confidence level are determined. A comparative analysis with other procedures is presented in tables. [J1400]

"Direction-finding of coherent sources via 'particle-velocity-field smoothing'"

A new 'particle-velocity-field smoothing' (PVFS) algorithm is proposed to decorrelate up to three coherent sources for azimuth-elevation direction-finding using vector-hydrophones in the underwater acoustic medium. The coherency among the incident sources would reduce the data correlation matrix's rank to below the number of incident sources, but this proposed algorithm restores the rank by summing the individual particle-velocity-field component's data correlation matrices. This scheme uses identically oriented underwater-acoustic vector-hydrophones, its locations may be arbitrary. Each underwater-acoustic vector-hydrophone consists of two or three collocated but orthogonally oriented velocity-hydrophones, and a pressure-hydrophone. In contrast to the customary 'spatial smoothing' technique, this proposed PVFS algorithm does not reduce the array's spatial aperture and does not require any 'virtual array interpolation' even for an irregularly shaped array grid. Monte Carlo simulations verify this proposed scheme's efficacy. [J1401]

"Sweep signal time-delay estimation with time-frequency cross-correlation algorithm"

Sweep signal is usually employed as a source signal in active detection such as radar and sonar. Since the frequency spectrum of the sweep signal varies against time, a novel algorithm, namely a time-frequency cross-correlation (TFCC) algorithm based on wavelet packet transform (WPT), is proposed to estimate the time delay of sweep signal. In this algorithm, the source sweep and the received signals are decomposed with WPT to obtain their time-frequency representations and the TFCC between the source sweep and the received signals is performed. Each reflected sweep in the received signal is converted into a time-frequency correlation peak whose position can indicate its time delay. The TFCC algorithm can suppress ambient noise effectively and

improve the performance of sweep extraction and can match more precisely the source and the reflected sweeps to their known time-frequency characters. Numerical experiments were performed to compare the performance of the TFCC algorithm with that of the conventional cross- correlation and phase-data algorithms. The results proved that the TFCC algorithm can extract the reflected sweeps effectively and its performance is better than that of the conventional algorithms. [J1402]

"Analytic Search Method for Interferometric SAR Image Registration"

We propose an analytic search method for interferometric synthetic aperture radar (InSAR) image registration. An analytic cost function is established, and the subpixel offsets associated with the maximum of the cost function are continuously searched by direction-alternate optimization methods along vertical and horizontal directions. We establish a novel dual-quartic analytic cost function for extraction of subpixel offsets from a corresponding pixel pair established by pixel-level registration. A robust optimization method that is called biiteration algorithm for searching the maximum point of the dual-quartic cost function is developed to solve the subpixel offsets. Since the dual-quartic cost function is quartic if one of two parameters is fixed, one of two substeps including in each iterative step of the efficient biiterative method is to find the solution by the secant method. The performances of the proposed method are shown by using simulated and real data and compared with those of representative existing registration method. [J1403]

"Spatial-temporal separable filter for adaptive clutter suppression in airborne radar"

A spatial-temporal separable filter (STSF) for adaptive clutter suppression in airborne radar is proposed. The STSF coefficients can be efficiently obtained by the proposed bi-iterative algorithm. The STSF performance is illustrated by experiment results on the simulated data and measured data. [J1404]

"Post-adaptive processing time-delay beamforming for clutter suppression in airborne radar"

A novel beamforming architecture is presented in which time delay steering is applied after the application of space-time adaptive processing (STAP) in a phased array for airborne radar. Improved clutter suppression and slow moving target detection performance can be achieved over that associated with STAP and conventional time delay steering in wideband sideways looking applications. The architecture also provides a computationally efficient means of applying time-delay beamforming in conjunction with STAP in applications where multiple receive beams are required. [J1405]

"Confocal Microwave Imaging for Breast Cancer Detection: Delay-Multiply-and-Sum Image Reconstruction Algorithm"

A new image reconstruction algorithm, termed as delay-multiply-and-sum (DMAS), for breast cancer detection using an ultra-wideband confocal microwave imaging technique is proposed. In DMAS algorithm, the backscattered signals received from numerical breast phantoms simulated using the finite-difference time-domain method are time shifted, multiplied in pair, and the products are summed to form a synthetic focal point. The effectiveness of the DMAS algorithm is shown by applying it to backscattered signals received from a variety of numerical breast phantoms. The reconstructed images illustrate improvement in identification of embedded malignant tumors over the delay-and-sum algorithm. Successful detection and localization of tumors as small as 2 mm in diameter are also demonstrated. [J1406]

"Estimation of the Temporal Evolution of the Deformation Using Airborne Differential SAR Interferometry"

This paper presents airborne differential synthetic aperture radar (SAR) interferometry results using a stack of 14 images, which were acquired by the Experimental SAR system of the German Aerospace Center (DLR) during a time span of 2.5 h. An advanced differential technique is used to retrieve the error in the digital elevation model and the temporal evolution of the deformation for every coherent pixel in the image. The two main limitations in airborne SAR processing are analyzed, namely, the existence of residual motion errors (RMEs) (inaccuracies in the navigation system on the order of 1-5 cm) and the accommodation of the topography and the aperture dependence on motion errors during the processing. The coupling between them is also addressed, showing that the estimation of the differential RME, i.e., baseline error, can be biased when using techniques based on the coregistration between interferometric looks. The SAR focusing chain to process the data is also presented together with the modifications in the differential interferometry processor to deal with the remaining baseline error. The detected motion of a corner reflector and the measured deformation in several agricultural fields allows one to validate the proposed techniques. [J1407]

"Removal of the Eye-Blink Artifacts From EEGs via STF-TS Modeling and Robust Minimum Variance Beamforming"

A novel scheme for the removal of eye-blink (EB) artifacts from electroencephalogram (EEG) signals based on a novel space--time--frequency (STF) model of EEGs and robust minimum variance beamformer (RMVB) is proposed. In this method, in order to remove the artifact, the RMVB is provided with aprioriinformation, namely, an estimation of the steering vector corresponding to the pointsourceEBartifact. The artifact-removed EEGs are subsequently reconstructed by deflation. The aprioriknowledge, the vector corresponding to the spatial distribution of the EB factor, is identified using the STF model of EEGs, provided by the parallel factor analysis (PARAFAC) method. In order to reduce the computational complexity present in the estimation of the STF model using the three-way PARAFAC, the time domain is subdivided into a number of segments, and a four-way array is then set to estimate the STF-time/segment (TS) model of the data using the four-way PARAFAC. The correct number of the factors of the STF model is effectively estimated by using a novel core consistency diagnostic-(CORCONDIA-) based measure. Subsequently, the STF-TS model is shown to closely approximate the classic STF model, with significantly lower computational cost. The results confirm that the proposed algorithm effectively identifies and removes the EB artifact from raw EEG measurements. [J1408]

"Radar Detection and Classification of Jamming Signals Belonging to a Cone Class"

This paper considers the problem of detecting and classifying a radar target signal and a jamming signal produced by a deception electronic counter measure (ECM) system based on a digital radio frequency memory (DRFM) device. The disturbance is modeled as a complex correlated Gaussian process. The jamming is modeled as a signal belonging to a cone whose axis is the true target signal. Two different approaches are analyzed, based on the adaptive coherent estimator (ACE) and on the generalized likelihood ratio test (GLRT), yielding both to a two-block device. The performance of the two detection/classification algorithms are evaluated, analytically, when possible, and by Monte Carlo simulation. [J1409]

"Theoretical Performance Analysis of the W-ABORT Detector"

In a recent paper we introduced a modification of the adaptive beaniformer orthogonal rejection test (ABORT) for adaptive detection of signals in unknown noise, by supposing under the null hypothesis the presence of signals orthogonal to the nominal steering vector in the whitened observation space. We will refer to this new receiver as the whitened adaptive beamformer orthogonal rejection test (W-ABORT). Through Monte Carlo simulations this new detector was shown to provide better rejection capabilities of mismatched (e.g., sidelobe) signals than existing ones, like ABORT or the adaptive coherence estimator (ACE), but at the price of a certain loss in terms of detection of matched (i.e., mainlobe) signals. The aim of this paper is to provide a theoretical validation of this fact. We consider both the case of distributed targets and point-like targets. We provide a statistical characterization of the W-ABORT test statistic, under the null hypothesis, and for matched and mismatched signals under the alternative hypothesis. For distributed targets, the probability of false alarm and the probability of detection can only be expressed in terms of multi-dimensional integrals, and are thus very complicated to obtain; in contrast, for point-like targets, such probabilities can be easily calculated by numerical integration techniques. The theoretical expressions derived herein corroborate the simulation results obtained previously. [J1410]

"Sampling Signals from a Union of Subspaces"

The single linear vector space assumption is widely used in modeling the signal classes, mainly due to its simplicity and mathematical tractability. In certain signals, a union of subspaces can be a more appropriate model. This paper provides a new perspective for signal sampling by considering signals from a union of subspaces instead of a single space. [J1411]

"Unified Anomaly Suppression and Boundary Extraction in Laser Radar Range Imagery based on a Joint Curve-Evolution and Expectation-Maximization Algorithm"

In this paper, we develop a new unified approach for laser radar range anomaly suppression, range profiling, and segmentation. This approach combines an object-based hybrid scene model for representing the range distribution of the field and a statistical mixture model for the range data measurement noise. The image segmentation problem is formulated as a minimization problem which jointly estimates the target boundary together with the target region range variation and background range variation directly from the noisy and anomaly-filled range data. This formulation allows direct incorporation of prior information concerning the target boundary, target ranges, and background ranges into an optimal reconstruction process. Curve evolution techniques and a generalized expectation-maximization algorithm are jointly employed as an efficient solver for minimizing the objective energy, resulting in a coupled pair of object and intensity optimization tasks. The

method directly and optimally extracts the target boundary, avoiding a suboptimal two-step process involving image smoothing followed by boundary extraction. Experiments are presented demonstrating that the proposed approach is robust to anomalous pixels (missing data) and capable of producing accurate estimation of the target boundary and range values from noisy data. [J1412]

"UWB Echo Signal Detection With Ultra-Low Rate Sampling Based on Compressed Sensing"

A major challenge in ultra-wide-band (UWB) signal processing is the requirement for very high sampling rate. The recently emerging compressed sensing (CS) theory makes processing UWB signal at a low sampling rate possible if the signal has a sparse representation in a certain space. Based on the CS theory, a system for sampling UWB echo signal at a rate much lower than Nyquist rate and performing signal detection is proposed in this paper. First, an approach of constructing basis functions according to matching rules is proposed to achieve sparse signal representation because the sparse representation of signal is the most important precondition for the use of CS theory. Second, based on the matching basis functions and using analog-to-information converter, a UWB signal detection system is designed in the framework of the CS theory. With this system, a UWB signal, such as a linear frequency-modulated signal in radar system, can be sampled at about 10% of Nyquist rate, but still can be reconstructed and detected with overwhelming probability. The simulation results show that the proposed method is effective for sampling and detecting UWB signal directly even without a very high-frequency analog-to-digital converter. [J1413]

"Ranging in a Single-Input Multiple-Output (SIMO) System"

In this letter, optimal ranging in a single-input multiple-output (SIMO) system is studied. The theoretical limits on the accuracy of time-of-arrival (TOA) (equivalently, range) estimation are calculated in terms of the Cramer-Rao lower bound (CRLB). Unlike the conventional phased array antenna structure, a more generic fading model is employed, which allows for the analysis of spatial diversity gains from the viewpoint of a ranging system. In addition to the optimal solution, a two-step suboptimal range estimator is proposed, and its performance is compared with the CRLBs. [J1414]

"Application of Bispectrum Estimation for Time-Frequency Analysis of Ground Surveillance Doppler Radar Echo Signals"

A microwave coherent homodyne and polarimetric ground surveillance Doppler radar is employed for collecting the radar returns from moving objects. Nonstationary nonlinearly frequency-modulated and multicomponent backscattered signals are analyzed and described as a sum of Doppler frequency-shifted polynomial chirp-like components. Instantaneous frequencies corresponding to the radiation backscattered by the different parts of a moving spatially distributed object are extracted from the time-varying bimagnitude estimates of transient sample sequences separated from the total received signal by a sliding window and projected into the time-frequency (TF) domain. Experimental investigations demonstrate a clean recovery of evolutionary phase-coupled harmonics for such targets as a swinging metallic sphere or a walking human. The computed TF distributions can be used in radar automatic target recognition systems to retrieve new data for the classification and recognition of ground moving objects. [J1415]

"Feature-based human motion parameter estimation with radar"

Radar can be an extremely useful sensing technique to observe persons. It perceives persons behind walls or at great distances and in situations where persons have no or poor visibility. Human motion modulates the radar signal which can be observed in the spectrogram of the received signal. Extraction of these movements enables the animation of a person in virtual reality. The authors focus on a fast feature-based approach to estimate human motion features for real-time applications. The human walking model of Boulic is used, which describe the human motion with three parameters. Personification information is obtained by estimating the individual leg and torso parameters. These motion parameters can be estimated from the temporal maximum, minimum and centre velocity of the human motion distribution. Three methods are presented to extract these velocities. Additionally, we extract an independent human motion repetition frequency estimate based on velocity slices in the spectrogram. Kalman filters smooth the parameters and estimate the global Boulic parameters. These estimated parameters are input to the human model of Boulic which forms the basis for animation. The methods are applied to real radar measurements. The animated person generated with the extracted parameters provides a realistic look-alike of the real motion of the person. [J1416]

"Oblique Projections for Direction-of-Arrival Estimation With Prior Knowledge"

Estimation of directions-of-arrival (DOA) is an important problem in various applications and a priori knowledge on the source location is sometimes available. To exploit this information, standard methods are based on the

orthogonal projection of the steering manifold onto the noise subspace associated with the a priori known DOA. In this paper, we derive and analyze the Cramer-Rao bound associated with this model and in particular we point out the limitations of this approach when the known and unknown DOA are closely spaced and the associated sources are uncorrelated (block-diagonal source covariance). To fill this need, we propose to integrate a priori known locations of several sources into the MUSIC algorithm based on oblique projection of the steering manifold. Finally, we show that the proposed approach is able to almost completely cancel the influence of the known DOA on the unknown ones for block-diagonal source covariance and for sufficient signal-to-noise ratio (SNR). [J1417]

"Fast and accurate radar cross-section computation over a broad frequency band using the best uniform rational approximation"

The method of moments (MOM) in conjugation with the best uniform rational approximation is applied to predict the broad-band radar cross-section of arbitrarily shaped three-dimensional (3D) bodies. The surface integral equations are solved using MOM to obtain the equivalent surface currents at the frequency points corresponding to the Chebyshev nodes, and then the surface current within the given frequency band is represented by the Chebyshev series. To improve the accuracy, the Chebyshev series is matched via the Maehly approximation to a rational function, which can be as good as the best uniform rational approximation. Using the rational function, the surface current is obtained at any frequency point within the frequency band. Numerical results for 3D arbitrarily shaped perfectly electric conducting objects and homogenous dielectric bodies are considered. Compared with the asymptotic waveform evaluation technique and the model-based parameter estimation, the proposed technique is accurate in much broader frequency band with lower memory required. [J1418]

"The Hybrid CramЙr-Rao Bound on Broadside DOA Estimation of Extended Sources in Presence of Array Errors"

In this correspondence we derive explicit expressions for the hybrid Cramer-Rao lower bound (HCRB) on the estimation accuracy of signal direction of arrival (DOA) from data collected by randomly perturbed arrays. The presence of a wavefront spatial decorrelation, which is modeled as a multiplicative correlated noise, has also been taken into account in the data model, since it is typical in those applications involving extended sources. In particular, we consider perturbations in sensor positions. Existing approaches to DOA HCRB calculation do not consider the presence of multiplicative noise and are referred to the assumption of small perturbations only, still not being worked out explicitly. Here, we assume that the impinging wavefronts are coming from broadside or more generally from a narrow DOA sector, allowing the explicit derivation of the HCRB for any variance of the sensor positioning errors in the line-of-sight direction. This scenario corresponds to the typical operative condition of remote sensing systems such as synthetic aperture radar (SAR) multibaseline interferometers, for which a few HCRB sample curves are reported. [J1419]

"Chirped RF Pulse Generation Based on Optical Spectral Shaping and Wavelength-to-Time Mapping Using a Nonlinearly Chirped Fiber Bragg Grating"

Chirped radio-frequency (RF) pulse generation based on optical spectral shaping and nonlinear wavelength-to-time mapping in a nonlinearly chirped fiber Bragg grating (NLCFBG) is investigated. In the proposed approach, the spectrum of a femtosecond pulse generated by a mode-locked fiber laser is shaped by an optical filter that has a sinusoidal frequency response. The spectrum-shaped optical pulse is sent to the NLCFBG, to implement nonlinear wavelength-to-time mapping. A chirped electrical pulse with the central frequency and chirp rate determined respectively by the first- and second-order dispersions of the NLCFBG is then obtained at the output of a high-speed photodetector. An approximate model that describes the chirped RF pulse generation is derived, which is verified by numerical simulations. Chirped pulse generation with a pulse compression ratio as high as 450 is demonstrated. The key device in the chirped RF pulse generation system is the NLCFBG, which is investigated in detail with an emphasis on the influence of its group delay ripples on the performance of the pulse generation system. Techniques to design and fabricate the NLCFBG are also discussed. The proposed approach provides a potential solution for the generation of chirped RF pulse with a high central frequency and large chirp rate for applications in pulse compression radar systems. [J1420]

"Using the Existing Spectral Clutter Filter With the Nonuniformly Spaced Time Series Data in Weather Radar"

The National Weather Service (NWS) has a network of weather surveillance Doppler radars, WSR-88D, that is routinely upgraded to reflect current technological and engineering advances. During the last decade, the staggered pulse repetition time (SPRT) was proposed to mitigate range/velocity ambiguity in WSR-88D; however, it could not be used at lowest elevation tilts due to the inability to filter ground clutter from the

nonuniformly spaced time series. A complicated spectral procedure was developed to address this issue, but the procedure was derived for a specific set of data acquisition parameters and used a lookup table to provide a value for the clutter spectrum width. Attempts to use SPRT with different sets of acquisition parameters always led to the degradation of filtering. It is proposed here that the clutter spectrum width be estimated by using Gaussian model adaptive processing (GMAP) that is currently used by NWS for uniformly sampled time series. GMAP is an adaptive ground clutter filter that performs an iterative fit of a Gaussian curve to the spectral coefficients identified as being due to ground clutter. GMAP cannot be used directly with the SPRT spectrum because of multiple clutter replicas that are due to staggered nonuniform sampling. However, the elements of GMAP can be exploited and used in the SPRT procedure. This letter presents how the elements of GMAP can be used with the SPRT data to provide successful clutter filtering at lowest elevation tilts. [J1421]

"An Error Prediction Framework for Interferometric SAR Data"

Three of the major error sources in interferometric synthetic aperture radar measurements of terrain elevation and displacement are baseline errors, atmospheric path length errors, and phase unwrapping errors. In many processing schemes, these errors are calibrated out by using ground control points (GCPs) (or an external digital elevation model). In this paper, a simple framework for the prediction of error standard deviation is outlined and investigated. Inputs are GCP position, aprioriGCP accuracy, baseline calibration method along with a closed-form model for the covariance of atmospheric path length disturbances, and a model for phase unwrapping errors. The procedure can be implemented as a stand-alone add-on to standard interferometric processors. It is validated by using a set of single-frame interferograms acquired over Rome, Italy, and a double difference data set over Flevoland, The Netherlands. [J1422]

"On the Design and Evaluation of Multiobjective Single-Channel SAR Image Segmentation Algorithms"

Multiobjective segmentation algorithms are based on an objective function, consisting of two or more terms, that is minimized by using an optimization algorithm. The objective terms represent differing segmentation objectives, the most popular of which are statistical likelihood of pixel values and smoothness of segment boundaries. Many assumptions are built into the objective function, and we present a case study based on the algorithm of Stewart to demonstrate the importance of analyzing algorithm characteristics to test the validity of hidden assumptions. We develop a set of simulated test images and a novel segmentation performance metric for use with simulated data. An innovative aspect of the Stewart algorithm (SA) is the probability of false alarm (PFA) model used to weight the objective terms. This is intended to dynamically balance the terms as the algorithm progresses. The PFA model is only valid for false edges, and we have shown that the number of selected true edges increases as segmentation evolves, making the theoretical weight model increasingly invalid. In addition, we found problems with several other algorithm assumptions. We tested algorithm performance against a fixed-weight version. We found that the performance of the SA was worse than a fixed-weight version. Thus, while the two-term objective function algorithm does deliver reasonable performance for multilook data, the fixed-weight version gives better performance. While these results hold only for simulated data, we believe that the experimental results indicate the need for a more powerful approach to multiobjective synthetic aperture radar segmentation. [J1423]

"A comparative study of model selection criteria for the number of signals"

The performance of six existing model selection criteria is compared, which are commonly used in time series and regression analysis, when they are applied to the problem of the number of signals in the multiple signal classification (MUSIC) method. The five criteria are Akaike Information Criterion (AIC), Hannan and Quinn Criterion, Bayesian Information Criterion (BIC), Corrected AIC (AICc) and the recently introduced Vector Corrected Kullback Information Criterion (KICvc) and Weighted-Average Information Criterion (WIC). The general form of the above information criteria consists of a log likelihood function expressed in terms of the eigenvalues of the sample covariance matrix and a unique penalty term. In our estimation procedure, the number of signals is obtained by minimising each of the above criteria. Several simulated data sets, including a linear antenna array data set, are adopted for the comparison purpose. The authors show that, in simple MUSIC additive white noise model, for small sample size n, WIC performs nearly as well as AICc and outperforms other criteria, and for moderately large to large n, WIC performs nearly as well as BIC and outperforms other criteria. Therefore when the authors are not certain of the relative sample size, WIC may be a practical alternative to any criterion. The main purpose is to draw the attention and interests of signal processing researchers to adopt more recent statistical model selection criteria, such as WIC, in general signal processing problems. [J1424]

"Fundamental resolution limits of closely spaced random signals"

Fundamental limitations on estimation accuracy are well known and include a variety of lower bounds including the celebrated Cramer-Rao lower bound. However, similar theoretical limitations on resolution have not yet been presented. The authors exploit results from detection theory for deriving fundamental limitations on resolution. In this correspondence the authors discuss the case of zero mean random Gaussian signals with a general and predefined covariance matrix observed with additive white Gaussian noise. The results are general and are not based on any specific resolution technique and therefore hold for any method and for any probability of successful resolution. The resolution limit is a simple expression of the observation interval, the pre-specified resolution success probability and the second derivative of the covariance matrix. As an example, the authors discuss the bearing resolution of two emitters with closely spaced direction of arrival, impinging on an array of sensors. The theoretical limits are compared with empirical performance of the model order selection criteria known as the Akaike information criterion and the minimum description length. [J1425]

"Noise Reduction in Interferograms Using the Wavelet Packet Transform and Wiener Filtering"

A novel noise reduction scheme for synthetic aperture radar (SAR) interferograms based on the wavelet packet transform (WPT) and the Wiener filter is introduced in this letter. First, by employing the WPT in the spatial frequency domain, the real and imaginary parts of the complex noisy interferogram are decomposed, respectively, and the wavelet coefficients are obtained. Then, for these coefficients, Wiener filtering is adopted to remove noise. This scheme can filter noise adaptively according to the local noise level, without requiring any a priori information. By using a simulated noisy interferogram and two ENVISAT advanced synthetic aperture radar C-band interferograms, the performance of this scheme, in terms of noise reduction and fringes preservation, is reported and compared with other filter algorithms. The experimental results demonstrate the effectiveness of the proposed scheme. [J1426]

"Some Aspects of Improving the Frequency Scaling Algorithm for Dechirped SAR Data Processing"

The frequency scaling algorithm (FSA) was proposed to process the synthetic aperture radar (SAR) data acquired via the dechirp-on-receive approach. Some aspects of improving the FSA are investigated in this paper, based on which an extended FSA (EFSA) is presented. The general purpose of the EFSA is to reduce the effect of range spectrum shift of the intermediate processing results, which occurs during the scaling operation in the FSA, so as to achieve a more effective utilization of the processed bandwidth. The EFSA is implemented through time shifting the scaling and the inverse scaling functions used in the FSA and also the adjustment of the scaling factor. The derivation of the EFSA is detailed in this paper. Point target simulation in squinted imaging geometry indicates that the presented algorithm is more suitable for large-squint applications. [J1427]

"Analysis of Ground-Based SAR Data With Diverse Temporal Baselines"

In this paper, the algorithms developed for satellite synthetic aperture radar (SAR) interferometry were adapted to the ground-based SAR (GB-SAR) configuration and used for detecting the displacements of an alpine landslide which have occurred over many years. Indeed GB-SAR interferometry is based on the same principles as satellite SAR techniques but benefits from the GB-SAR's versatility and capability of gathering many images per day. In monitoring applications of landslides moving only few centimeters per year, as the case here reported, the GB-SAR sensor is installed at repeated intervals several months apart over the observation period. Although the revisiting time is very similar to the satellite one, for each survey, lasting two or three days, more than ten images are available. They are analyzed separately and in combination with images from other surveys for coherent pixel selection. Interferograms are formed by cross-combining images from different surveys. Finally, the evolution of the deformation across the surveys is retrieved in a least square sense without any assumptions on its regularity. The used GB-SAR technique is described in detail in this paper, and the results obtained with regard to a landslide in the Italian Alps that has been monitored over a period of about three years are discussed. [J1428]

"An Artificial-Neural-Network-Based Integrated Regional Model for Rain Retrieval Over Land and Ocean"

An integrated regional model is proposed for rain-rate retrievals over land/ocean from the brightness temperature (Tb) values of the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI). The polarization-corrected temperature calculated from the 85.5-GHz channels is also considered as one of the inputs along with the nine channel Tb values. This model is applicable over the region between and . For this purpose, an artificial neural network is utilized. The collocated precipitation radar (PR) near-surface rain rates as given by a 2A25 data product is considered as a target value. The methodology consists of the separation of land and ocean pixels, the separation of stratiform and convective pixels over land/ocean, and the selection of important features (inputs) for the multilayer perceptron network by the feature selection technique for each group. For the

separation of land/ocean pixels, the Tb values of the 10.65-GHz vertical channel are utilized. The values are utilized to separate the stratiform and convective pixels both over land and ocean. The rain retrieval from the developed model is validated with TRMM PR. Overall result shows the better agreement of the model-retrieved rain rate with the PR observation compared to the TMI (2A12) rain rate particularly over land. The rain retrieved from the developed model is further validated with Doppler weather radar. A reasonably good agreement is observed between these two estimations. [J1429]

"The Hunt For The Kill Switch"

This paper has described the issues on electronic circuits which are made for military equipments.The DoD of U.S. recently launched its most ambitious program yet to verify the integrity of the electronics that will underpin future additions to its arsenal. The Defense Advanced Research Projects Agency (DARPA), the Pentagon's R&D wing, and released details about a three-year initiative it calls the Trust in Integrated Circuits program. The findings from the program could give the military and defense contractors who make sensitive microelectronics like the weapons systems for the F-35 a guaranteed method of determining whether their chips have been compromised. The Trust program started its prequalifying rounds by sending to three contractors four identical versions of a chip that contained unspecified malicious circuitry, though U.S. military consumes only 1% of world's integrated circuits. [J1430]

"POLSAR Image Analysis of Wetlands Using a Modified Four-Component Scattering Power Decomposition"

It is important to monitor environmental changes of the Earth's cover by remotely sensed data. This paper analyzes seasonal changes of a wetland by a modified polarimetric four-component scattering power decomposition method. The data sets analyzed here are L- and X-band fully polarimetric synthetic aperture radar (POLSAR) data, which have been acquired by the NICT/JAXA airborne polarimetric and interferometric synthetic aperture radar system in 2004. Since there existed a deficiency in the currently adopted decomposition schemes in that negative powers appear in a few pixels in the image analysis, we modified the approach taking into account physical conditions. It is shown by the modified scheme that the seasonal changes and features of the vegetation near Sakata Lagoon in Niigata, Japan, are observed clearly, demonstrating the utility of POLSAR image analysis for wetland assessments in general. [J1431]

"Characteristics of TRMM/PR System Noise and Their Application to the Rain Detection Algorithm"

This study investigates the characteristics of system noise sampled by the Precipitation Radar (PR) onboard the Tropical Rainfall Measuring Mission satellite. First, we examine the long-term trend in system noise. The result shows that the system noise level was quite stable for a long time period except for a few sudden change events. The averaged system noise shows a periodic change that relates to the temperature of the PR. This change corresponds to the changes in the solar beta angle, and the amplitude of the fluctuation is about 0.15 dB. The contribution of surface emission from the ocean to the system noise is also examined by averaging the system noise data under a no-rain condition over a long period (e.g., one month) to remove the effect of the temperature fluctuation related to the solar beta angle. The resulting amplitude is less than 0.1 dB, and the spatial distribution almost corresponds to the pattern of the sea surface temperature. These results confirm that the system noise of the PR is quite stable, indicating that the fluctuation of the sampled system noise is caused mainly by the fading effect. The characteristics of the system noise of three rain categories-ldquorain certain,rdquo ldquorain possible,rdquo and ldquono-rainrdquo-are examined by taking a histogram. Because the PRpsilas system noise is supposed to be stable, broadening the system noise level of about 2.5 dB almost corresponds to the fading effect. The histograms of rain-certain and of no-rain show a similar shape with a difference of a few tenths of decibels. The higher noise levels in rain-certain conditions are caused by the emission from raindrops. In contrast, the rain-possible histogram shows a widespread and skewed shape. It can be explained by saying that the rain-possible pixels are obtained when the sampled noise level is made accidentally small by the fading effect. Therefore, a fixed noise level threshold is introduced to the rain/no-rain classification for a more rel--iable rain-possible classification. The result shows that the rain area increases by about 15%, and the amount of rainfall increases by about 1% by adding reliable rain-possible pixels to the current standard product. [J1432]

"Quantifying Bird Migration by a High-Resolution Weather Radar"

We propose a bird detection and count algorithm designed to work with radar maps of plan-position-indicator type. The spatial arrangement of birds is modeled according to the Poisson distribution. It is possible to handle a nonuniform target distribution both on the vertical and horizontal planes. The method is applied to measurements carried out by an S-band Doppler weather radar located on the south side of the Alps. Quantitative estimates are

given for the distribution of bird volume density with height, the cumulative density (integrated over height), and, finally, the daily migration traffic rate of nocturnal migrants over an area of about 2000 km2. [J1433]

"Asymptotic solutions to multidimensional rapidly-oscillating integrals"

Derived are asymptotic solutions to rapidly-oscillating d-dimensional integrals that have superior convergence properties than conventional numerical-quadrature techniques. The approach is analogous to the theory of steepest descent which utilises the fact that the first derivatives of a function vanish at certain critical points. The approach is demonstrated by solving the electromagnetic scattering integral for a curved surface. [J1434]

"Reply to "Comments on 'Discrete Frequency-Coding Waveform Design for Netted Radar Systems'""

For original paper see H. Deng, ibid., vol.11, no.2, p.179-182, (2004). This paper presents reply to "comments on 'discrete frequency-coding waveform design for netted radar systems'". [J1435]

"Quasi-continuous waveform design for dynamic range reduction"

A study of quasi-continuous waveform and its performance in detection is presented, taking into consideration eclipsing loss and free- space decay. A genetic algorithm is then used to optimise the waveform and lower the dynamic range of the matched filtering output. The resulting waveform with high duty cycle and minimal loss at maximal range maintains good detection performance along the whole operating range of the radar. [J1436]

"Sampling Procedures for Resonance Based Radar Target Identification"

The performance of radar target identification using the natural E-Pulse technique is significantly degraded if the sampling rates of the target response and the E-Pulse filter are ignored. In this work, improved sampling procedures over that previously reported by Antony and Shuley (Electron. Lett., vol. 40) in 2004 are proposed. Numerical results demonstrate that the proposed procedures significantly improve the target identification performance. [J1437]

"Impact of Biannual Rossby Waves on the Indian Ocean Dipole"

TOPEX/Poseidon sea surface height anomalies during 1993-2002 are decomposed using 2-D finite impulse response filters which showed biannual Rossby waves (BRWs) in the equatorial Indian Ocean (peak at 1.5degS) and in the southern tropical Indian Ocean (peak at 10.5degS) during Indian Ocean dipole (IOD) years. Anomalous downwelling BRWs in the equatorial Indian Ocean triggered by the wind stress curl-induced Ekman pumping near the eastern boundary started propagating westward from the eastern boundary in July/August 1993 and 1996, i.e., more than one year prior to the formation of the IOD events of 1994 and 1997 respectively. These strong downwelling signals reach the western equatorial Indian Ocean during the peak dipole time. [J1438]

"Constant false-alarm rate algorithm based on test cell information"

A new constant false-alarm rate (CFAR) detection algorithm, designated as switching CFAR (S-CFAR), is proposed and analysed. The S-CFAR algorithm selects CFAR reference samples using the magnitude of the sample in the cell under test, which is an information that has not been exploited in any other existing CFAR detectors. S-CFAR closed-form analysis is presented, and comparisons with other representative CFAR algorithms are given. An S-CFAR detector can be tuned such that it has a small CFAR loss when operating on a homogeneous background while achieving improved robustness in the presence of interfering targets and clutter power transition. The S-CFAR detector is also simple to design and implement since no sample ordering is required. [J1439]

"Physical Optics Curved-Boundary Dielectric Plate Scattering Formulas for an Accurate and Efficient Electromagnetic Characterization of a Class of Natural Targets"

Closed-form representations of the physical optics (PO) field scattered in the far zone by plane penetrable dielectric angular sectors of arbitrary opening angle featuring a conical-section boundary are derived in terms of incomplete cylindrical functions (ICFs). The proposed expressions, possibly in combination with PO formulas for the scattering from polygonal plates, allow one to evaluate the scattering from flat dielectric plates with both convex and concave curved edges in a very efficient manner and constitute a useful tool to improve the accuracy of the geometrical characterization of a class of natural scatterers. In order to check the correctness and computational effectiveness of the proposed scattered-field solutions, comparisons with results obtained by

accurate completely numerical PO calculations are provided. Simulation data by the method of moments are also presented to assess the applicability of the PO approximation to the considered sample scattering geometries. [J1440]

"Sequential Along-Track Integration for Early Detection of Moving Targets"

This paper concerns the joint multiframe sequential target detection and track estimation in early-warning radar surveillance systems. The rationale for applying sequential procedures in such a scenario is that they promise a sensitivity increase of the sensor or, alternatively, a reduction in the time needed to take a decision. Unlike previous works on sequential radar detection, the attention is not restricted to stationary targets, namely position changes during the illumination period are allowed. Starting from previous sequential rules, different truncated sequential strategies are proposed and assessed: they are aimed at orienting the sensor resources towards either the detection or the track estimation or the position estimation. Bounds on the performances of the proposed procedures in terms of the system parameters are derived and computational complexity is examined. Also, numerical experiments are provided to elicit the interplay between sensor-target parameters and system performances, and to quantify the gain with respect to other fixed-sample-size procedures. [J1441]

"Traffic Surveillance System Based on a High-Resolution Radar"

Traffic surveillance is an important civilian application of radars. The current high-resolution radars give new opportunities so that the traffic application may be redefined. In this paper, a traffic scenario with a high-resolution radar is presented. A range-bin alignment method, the Global Range Alignment, which comes from the focusing techniques in inverse synthetic aperture radar, is applied to obtain further capabilities than the usual velocity measurement: distinction between vehicle types via length estimation and adequate management in situations with simultaneous targets. Preliminary results from a real scenario using a high-resolution linear frequency-modulated continuous-wave millimeter-wave radar are shown. [J1442]

"Refocusing Through Building Walls Using Synthetic Aperture Radar"

Through-wall imaging/sensing using a synthetic aperture array technique is studied by employing ultrawideband antennas and for wide incidence angles. The propagation through building walls, such as brick and poured concrete in response to point sources near the walls, is simulated by using high-frequency methods. Reciprocity is used to find the responses of point targets behind walls, which are then used to simulate the synthetic aperture radar (SAR) imaging through the walls. The effect of building walls on the target-image distortions is investigated by simulations and measurements. It is shown that by using the idea of match filtering, the effect of the wall can be compensated for, and the point target response can be reconstructed, provided that the wall parameters are known. An optimization method based on minimization of squared error in the SAR image domain within an area confined within the expected point-spread function is used to estimate the wall parameters and sharpen the image simultaneously. A controlled experiment within the laboratory environment is performed to verify the methods presented. It is shown that for an ultrawideband system operating over a frequency band of 1-3 GHz, highly distorted images of two point targets in close proximity of each other behind a wall can be resolved after refocusing. A dual-frequency synthetic method is also presented that can improve the cross-range resolution of the refocused image. [J1443]

"Radar HRRP Statistical Recognition: Parametric Model and Model Selection"

Statistical modeling for radar high-resolution range profile (HRRP) is a challenging task in radar HRRP statistical recognition. Theoretical analysis and experimental results show that elements in an HRRP sample are statistically correlated and non-Gaussian distributed. First, this paper introduces three joint-Gaussian models, i.e., subspace approximation model, probability principal components analysis (PPCA) model and factor analysis (FA) model, into radar HRRP statistical recognition. Due to the experimental results, we can have the conclusion that the jointly non-Gaussian distributed HRRP samples approximately follow the joint-Gaussian distribution described by FA model. Therefore, we can apply FA model to radar HRRP statistical recognition rather than a joint-Gaussian mixture model, e.g., PPCA mixture model or FA mixture model, which is a more accurate choice for modeling non-Gaussian distributed correlations in multidimensional data but with high learning complexity and large computation burden, and the difficulty in the statistical modeling for HRRP samples is largely reduced. Second, this paper concerns model selection of FA model in radar HRRP statistical recognition, in which there are two issues, i.e., the partition of target-aspect frames and the determination of the number of factors in each frame. Based on the Akaike information criterion (AIC) and the Bayes' information criterion (BIC), an iterated algorithm for model selection is proposed in this paper, which can automatically give the optimal aspect-frame boundaries and determine the optimal number of factors in each aspect-frame. The recognition experiments based on measured data show that the proposed adaptive partition approach can further improve the recognition

performance with higher recognition efficiency. [J1444]

"Fast Algorithms for Polynomial Time-Frequency Transforms of Real-Valued Sequences"

This paper presents fast algorithms for computing the polynomial time-frequency transform that deals with a real-valued sequence of length-apb, where a, b and p are positive integers. In particular, it shows that the polynomial time-frequency transform has a conjugate symmetric property, similar to that of the discrete Fourier transform, if the input sequence is real-valued. The computational complexities needed by these proposed algorithms are analyzed in terms of the numbers of real additions and real multiplications. When a=3,4, and 8, comparisons show that the computational complexities required by the proposed algorithms are less than 60% of those needed by the fast algorithms for complex-valued sequences. [J1445]

"On Using a priori Knowledge in Space-Time Adaptive Processing"

In space-time adaptive processing (STAP), the clutter covariance matrix is routinely estimated from secondary ldquotarget-freerdquo data. Because this type of data is, more often than not, rather scarce, the so-obtained estimates of the clutter covariance matrix are typically rather poor. In knowledge-aided (KA) STAP, an a priori guess of the clutter covariance matrix (e.g., derived from knowledge of the terrain probed by the radar) is available. In this note, we describe a computationally simple and fully automatic method for combining this prior guess with secondary data to obtain a theoretically optimal (in the mean-squared error sense) estimate of the clutter covariance matrix. The authors apply the proposed method to the KASSPER data set to illustrate the type of achievable performance. [J1446]

"Fiber lasers: A future technology for lasers in space"

The constraints of operation in space have largely precluded the use of conventional solid-state laser systems for applications including remote sensing, communication relays, and active laser radars. A new technology, fiber lasers, may offer all of the needed features at an affordable price. An appealing aspect of the fiber laser is that it does not need a rigid optical bench. Only the output end of the fiber need be held in rigid reference to the optical tracking system. Design, fabrication, and testing of the laser resonator is generally the most expensive and longest lead part of the effort for conventional solid-state lasers. Advances in fiber optic technology and devices mean that the "fiber laser" need not be a simple device but may be a complex system employing sophisticated technology, such as wavelength selective Bragg reflectors and nonlinear optical frequency shifters. Three companies have obtained single-mode outputs of 35-40 watts single mode at 1.03-1.1 mu. [J1447]

"SIP-based mobility management in next generation networks"

The ITU-T definition of next generation networks includes the ability to make use of multiple broadband transport technologies and to support generalized mobility. Next generation networks must integrate several IP-based access technologies in a seamless way. In this article, we first describe the requirements of a mobility management scheme for multimedia real-time communication services; then, we report a survey of the mobility management schemes proposed in the recent literature to perform vertical handovers between heterogeneous networks. Based on this analysis, we propose an application-layer solution for mobility management that is based on the SIP protocol and satisfies the most important requirements for a proper implementation of vertical handovers. We also implemented our proposed solution, testing it in the field, and proving its overall feasibility and its interoperability with different terminals and SIP servers. [J1448]

"Possibilistic Versus Belief Function Fusion for Antipersonnel Mine Detection"

Two approaches for combining humanitarian mine detection sensors are presented-one based on belief functions and the other one based on possibility theory. The approaches are described in parallel. First, different measures are extracted from the sensor data. Mass functions and possibility distributions are then derived from the measures based on prior information. After that, the combination of masses and the combination of possibility degrees are performed in two steps, on a separate sensor level and between the sensors. Combination operators are chosen to account for different characteristics of the sensors. The selection of the decision rules is discussed for both approaches. The proposed approaches are illustrated on a set of real mines and nondangerous objects, and promising results have been obtained. [J1449]

"Neuroinspired Architecture for Robust Classifier Fusion of Multisensor Imagery"

Two new algorithms for robust and fault-tolerant classifier combination are presented. The attractor dynamics (AD) algorithm models some properties of sensory integration in the central nervous system and is based on the application of the dynamical systems for classifier fusion. The classifier masking (CM) algorithm is a nonneural

version of the AD algorithm based on finding intersecting classifier intervals. Both of the proposed algorithms employ the idea of consensus among individual classifiers. The individual classifiers have been trained using resampled feature sets. They fuse the information from advanced synthetic aperture radar, medium resolution imaging spectrometer, and advanced along track scanning radiometer envisat satellite sensors for the improved sea ice classification. The results of our experiments show that training and combing the individual classifier outputs in a multiple classifier system significantly improve the robustness and the fault tolerance of the classification system as compared to the single classifier combining all sources of information. The robustness of the single classifier has been largely reduced in cases of single sensor failures (87.9 % in normal conditions versus 64.8% and 66.1% for two artificially corrupted data sets), whereas the CM algorithm is more tolerant to the sensor and preprocessing errors (86.4% in normal conditions versus 78.9% and 73.6% for two artificially corrupted data sets). The performance of the CM algorithm is superior to those of the simple multiple classifier combination strategies based on classifier averaging and majority voting (78.9% versus 70.9% and 69.5%, respectively) because the AD and CM algorithms are able to discard the corrupted classifier outputs based on classifier agreement and, in fact, represent hybrid approaches combining the properties of classifier averaging and classifier selection methods. [J1450]

"A Multiagent Swarming System for Distributed Automatic Target Recognition Using Unmanned Aerial Vehicles"

Over the past few years, automatic target recognition (ATR) has emerged as an essential image analysis tool to identify objects from temporally and spatially disjoint possibly noisy image data. For many current applications, ATR is performed by unmanned aerial vehicles (UAVs) that fly within a reconnaissance area to collect image data through sensors and upload the data to a central ground control station for analyzing and identifying potential targets. The centralized approach to ATR introduces several problems, including scalability with the number of UAVs, network delays in communicating with the central location, and the susceptibility of the system to malicious attacks on the central location. These challenges can be addressed by using a distributed system for performing ATR. In this paper, we describe a multiagent-based prototype system that uses swarming techniques inspired from insect colonies to perform ATR using UAVs in a distributed manner within simulated scenarios. We assume that UAVs are constrained in the resources available onboard and in their capabilities for performing ATR due to payload limitations. Our focus in this paper is on the coordination aspects between UAVs to efficiently decide how they are to act by using a swarming mechanism. We describe algorithms for the different operations performed by the UAVs in the system and for different swarming strategies, which are embedded within software agents located on the UAVs. We provide empirical simulations of our system within a simulated area of interest to determine its behavior in different scenarios with varying operational constraints. Our experimental results indicate that swarming strategies for distributed ATR perform favorably compared with centralized ATR strategies. [J1451]

"Fusion of Hyperspectral and LIDAR Remote Sensing Data for Classification of Complex Forest Areas"

In this paper, we propose an analysis on the joint effect of hyperspectral and light detection and ranging (LIDAR) data for the classification of complex forest areas. In greater detail, we present: 1) an advanced system for the joint use of hyperspectral and LIDAR data in complex classification problems; 2) an investigation on the effectiveness of the very promising support vector machines (SVMs) and Gaussian maximum likelihood with leave-one-out-covariance algorithm classifiers for the analysis of complex forest scenarios characterized from a high number of species in a multisource framework; and 3) an analysis on the effectiveness of different LIDAR returns and channels (elevation and intensity) for increasing the classification accuracy obtained with hyperspectral images, particularly in relation to the discrimination of very similar classes. Several experiments carried out on a complex forest area in Italy provide interesting conclusions on the effectiveness and potentialities of the joint use of hyperspectral and LIDAR data and on the accuracy of the different classification techniques analyzed in the proposed system. In particular, the elevation channel of the first LIDAR return was very effective for the separation of species with similar spectral signatures but different mean heights, and the SVM classifier proved to be very robust and accurate in the exploitation of the considered multisource data. [J1452]

"Retrieval of Snow and Rain From Combined X- and W-Band Airborne Radar Measurements"

Two independent airborne dual-wavelength techniques, based on nadir measurements of radar reflectivity factors and Doppler velocities, respectively, are investigated with respect to their capability of estimating microphysical properties of hydrometeors. The data used to investigate the methods are taken from the ER-2 Doppler radar (X-band) and cloud radar system (W-band) airborne Doppler radars during the Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment campaign in 2002. Validity is assessed by the degree to

which the methods produce consistent retrievals of the microphysics. For deriving snow parameters, the reflectivity-based technique has a clear advantage over the Doppler-velocity-based approach because of the large dynamic range in the dual- frequency ratio (DFR) with respect to the median diameter D0and the fact that the difference in mean Doppler velocity at the two frequencies, i.e., the differential Doppler velocity (DDV), in snow is small relative to the measurement errors and is often not uniquely related to D0. The DFR and DDV can also be used to independently derive D0in rain. At W-band, the DFR-based algorithms are highly sensitive to attenuation from rain, cloud water, and water vapor. Thus, the retrieval algorithms depend on various assumptions regarding these components, whereas the DDV-based approach is unaffected by attenuation. In view of the difficulties and ambiguities associated with the attenuation correction at W-band, the DDV approach in rain is more straightforward and potentially more accurate than the DFR method. [J1453]

"Multisensor Data Product Fusion for Aerosol Research"

Combining data sets from multiple satellite sensors is a powerful method for studying Earth-atmosphere problems. By fusing data, we can utilize the strengths of the individual sensors that may not be otherwise possible. In this paper, we provide the framework for combining level 2 data products, using data from three sensors aboard the National Aeronautics and Space Administration (NASA)'s Terra satellite. These data include top-of-the-atmosphere (TOA) radiative energy fluxes obtained from the Clouds and the Earth's Radiant Energy System (CERES), aerosol optical thickness from the multispectral Moderate Resolution Imaging Spectroradiometer (MODIS), and aerosol properties from the Multi-angle Imaging SpectroRadiometer (MISR). The CERES Single Scanner Footprint (SSF) contains the pixel level CERES TOA fluxes and the level 2 MODIS aerosol data. We specifically focus upon fusing the CERES SSF with the MISR aerosol products. Although this project was undertaken specifically to address aerosol research, the methods employed for fusing data products can be used for other problems requiring synergistic data sets. We present selected case studies over different aerosol regimes and indicate that multisensor information provides value-added information for aerosol research that is not available from a single sensor. [J1454]

"A Conceptual Framework for Ranking R&D Projects"

A framework for R&D project ranking that can help a firm improve its competitive advantage is presented. The framework integrates elements of previously published R&D project ranking systems and was refined through practitioner evaluation and utilization. Through use of the framework, an organization can increase the objectivity, accountability, and transparency of its strategic decision-making process. Real world tradeoffs are accounted for by evaluating projects in terms of the following perspectives: reasonableness, attractiveness, responsiveness, competitiveness, and innovativeness. Each perspective is represented by multiple criteria measured via descriptive values distributed over a standardized scale. The framework is operationalized by a toolset consisting of a project evaluation form, pairwise comparison matrices, a weighted scoring model, a scorecard, and radar diagrams. A firm customizes the framework by using pairwise comparison matrices to establish relative weights that reflect the firm's unique objectives and competitive environment. Reviewers score each project's criteria on evaluation forms. Weights and criteria scores are entered onto the scorecard through which the scoring model produces a rank-ordered project list. Radar diagrams display how well a firm's portfolio matches its R&D goals. These framework artifacts produce a decision reasoning audit trail that an organization can use to improve its ranking process. [J1455]

"Interference of a long dielectric string with a short metallic wire in RCS measurements"

When a metal wire supported by a dielectric string is held at broadside to the incident wave, the back-scattered contributions from them are opposite in phase. We present measured RCS patterns and compare these with simulated responses from simple theory. The excellent agreement led us to conclude that both the measurements and the theory are sound. [J1456]

"Two-dimensional frequency estimation using non-unitary joint diagonalisation"

Joint diagonalisation (JD) is an effective tool in many signal processing applications. A non-unitary JD method is proposed to estimate the two- dimensional (2D) frequencies. Experiments show that the proposed algorithm achieves good performance and the estimated 2D frequencies can be paired automatically. [J1457]

"How Does Multiple Scattering Affect the Spaceborne W-Band Radar Measurements at Ranges Close to and Crossing the Sea-Surface Range?"

A radar simulator capable of treating multiple-breakscattering effects has been upgraded to include the interaction with a Kirchoff surface, which realistically reproduces the effect of water surfaces. Multiple-scattering effects explain in a straightforward way some peculiar features of the first images delivered by the 94-GHz

cloud-profiling radar onboard the CloudSat, overpassing precipitating systems. The reflectivity profiles without the usual peaks at surface range are found to be distinctive signatures of strong multiple scattering. Moreover, multiple scattering is responsible for producing long signal tails at apparent ranges far below the surface with a strong sensitivity on the microphysical assumptions of the icy segment of the cloud. The estimates of multiple-scattering enhancement at surface and close to the surface range and the saturation levels for simplified precipitating profiles for both CloudSat and EarthCARE configurations are provided. [J1458]

"A New Look at the Bistatic-to-Monostatic Conversion for Tandem SAR Image Formation"

The bistatic synthetic aperture radar (SAR) data, which are converted into equivalent monostatic data by proper preprocessing, can be processed by standard monostatic focusing algorithms. The dip moveout (DMO) approach, which is derived from seismic data processing, converts the bistatic data into equivalent monostatic data by a short time-domain Rocca's smile operator. A 2D exact point-target (PT) reference spectrum is derived in this letter for the tandem bistatic configuration. The geometry-based bistatic formulation is shown to be actually equivalent to Rocca's smile operator, although they are derived from the pure SAR and geophysics points of view, respectively. Moreover, the new PT spectrum can be extended to deal with azimuth-invariant bistatic SAR data. Interpretations on the equivalent monostatic range wavenumber are presented in this letter, which help understand the conversion from the radar signal processing viewpoint. [J1459]

"UWBUSIS 2008"

{no data available} [J1460]

"Ground Moving Target Indication Using an InSAR System With a Hybrid Baseline"

In this letter, a two-channel airborne experimental interferometric synthetic aperture radar (InSAR) designed for terrain height estimation is exploited to acquire the ability of ground moving target indication (GMTI). Due to the hybrid baseline of this system, the interferometric phase changes with the target motion as well as the terrain height. The fluctuation of the interferometric phase worsens the performance of the clutter suppression and the radial velocity estimation. In order to resolve this problem, a GMTI method with three steps is proposed. After two steps are used to eliminate the local flat-Earth phase and the cross-track interferometric phase of the scene, respectively, an adaptive filtering method is used to suppress the stationary clutter with the benefit of calibrating the sensor responses. A conventional constant false alarm rate detector is then used to indicate the moving targets. The validity of the proposed method is demonstrated with real data collected using an experimental airborne InSAR system. [J1461]

"Radar: A case history of an invention [JPublication Review]"

This is a review of Part 2 of the August 2006 issue (vol. 21, no. 8). [J1462]

"Radar cross section (RCS) modeling and simulation, part 1: a tutorial review of definitions, strategies, and canonical examples"

Modeling and simulation strategies for radar cross section (RCS) prediction are reviewed, and a novel FDTD-based virtual RCS prediction tool is introduced in this two-part paper. Part 1 is reserved for a tutorial review. Concepts and definitions related to RCS modeling are outlined. Analytical approaches, i.e., high-frequency asymptotics (HFA), as well as powerful time- and frequency-domain numerical methods, are given. Canonical examples using the finite-difference time-domain (FDTD) Method, the method of moments (MoM), and physical optics (PO) are presented. [J1463]

"The Doppler wheel revisited"

Millimeter-wave radar returns from cylindrical targets, such as artillery shells or helicopter rotor shafts, can be experimentally evaluated with the classic Doppler wheel. This also is a simple autonomous calibration tool for radar development and field testing. However, the less-apparent wheel-return characteristics found in practice must be taken into account. Doppler spectra for speeds up to 3000 rpm measured with a Ka-band radar against a 100 mm-diameter flat cylinder are presented, showing a frequency range from 200 to 4200 Hz. Meaningful signal amplitudes were measured up to the rim-speed Doppler. Frequency components beyond the range defined by the local radial velocity of the illuminated portion were observed up to 2500 Hz. Miniature surface deformations increased the amplitude of the highest frequencies by 5-10 dB. Simulated spectra agreed with measurement results at the higher Doppler frequencies, but a model based on Physical and Geometrical Optics failed to explain the low-frequency components. [J1464]

"Design, optimization, and validation of a planar nine-element quasi-Yagi antenna array for X-band applications [Jantenna designer's notebook]"

First Page of the Article [J1465]

"RadarCon 2008 in Rome"

{no data available} [J1466]

"MIMO Radar with Widely Separated Antennas"

MIMO (multiple-input multiple-output) radar refers to an architecture that employs multiple, spatially distributed transmitters and receivers. While, in a general sense, MIMO radar can be viewed as a type of multistatic radar, the separate nomenclature suggests unique features that set MIMO radar apart from the multistatic radar literature and that have a close relation to MIMO communications. This article reviews some recent work on MIMO radar with widely separated antennas. Widely separated transmit/receive antennas capture the spatial diversity of the target's radar cross section (RCS). Unique features of MIMO radar are explained and illustrated by examples. It is shown that with noncoherent processing, a target's RCS spatial variations can be exploited to obtain a diversity gain for target detection and for estimation of various parameters, such as angle of arrival and Doppler. For target location, it is shown that coherent processing can provide a resolution far exceeding that supported by the radar's waveform. [J1467]

"A Method for Soil Moisture Estimation in Western Africa Based on the ERS Scatterometer"

The analysis of feedback phenomena, which occur between continental surfaces and the atmosphere, is one of the keys to an improved understanding of African monsoon dynamics. For this reason, the monitoring of surface parameters, particularly soil moisture, is very important. This paper presents a new methodology for the estimation of surface soil moisture over Western Africa based on the data provided by the European Remote Sensing wind scatterometer instrument, in which an empirical model is used to estimate volumetric soil moisture. This approach takes into account the effects of vegetation and soil roughness in the soil moisture estimation process. The proposed estimations have been validated using different methods, and a good degree of coherence has been observed between satellite estimations and ground truth measurements over the Banizambou site in Niger. Moisture and rainfall estimations for the same site are shown to be strongly correlated. Comparison with the multimodel analysis product provided by the Global Soil Wetness Project, Phase 2, indicates that their estimations are well correlated, although land surface models provide slightly overestimated levels of soil moisture. [J1468]

"Three-Dimensional ISAR Imaging Based on Antenna Array"

In this paper, a 3D inverse synthetic aperture radar (ISAR) imaging method based on an antenna array configuration is proposed. The performance of conventional interferometric ISAR imaging system using three antennas is poor, as the positions of scatterers, which have the same range-Doppler value and projected onto the ISAR plane as a synthesis scatterer, cannot be correctly estimated. However, by using two antenna arrays perpendicular to each other, the system's ability to separate these scatterers can be improved. The criterion for the selection of a range unit that contains an isolated scatterer in the 2-D array domain for doing motion compensation is discussed. If there is no range unit which contains only an isolated scatterer, then radial and cross-range motion compensation has to be carried out by motion parameter estimation. Two cross-range motion parameters measurement algorithms, one based on array processing of the range profile and another based on correlation of ISAR images of different antennas, are proposed. The coordinates registration problem for the scatterers of a synthesis scatterer is also discussed. Simulation results have shown the effectiveness of the proposed methods. [J1469]

"Stokes Antenna Temperatures"

The growing importance of polarimetric radiometers has led to the need for a detailed theory for Stokes antenna temperatures. In this paper, we provide a full Stokes vector formulation of an antenna temperature that accounts for the entire antenna pattern, which includes polarization mixing in the main-beam and sidelobe effects. To derive the Stokes antenna temperatures, we follow the conventional methods in the Earth remote sensing literature while relying on a coherency algebra approach from radio astronomy. Connections and parallels to the conventional approaches are noted along the way. We also introduce generalizations of beam efficiency and cross polarization for use with polarimetric radiometers. These provide important metrics in the design of future systems. [J1470]

"Modeling of the Bistatic Electromagnetic Scattering From Sea Surfaces Covered in Oil for Microwave Applications"

This paper describes the influence of oil pollution over sea surfaces on the height spectrum and the height autocorrelation function of rough surfaces. An oil slick damps the capillarity waves of the surface height spectrum and reduces the root mean square slope of the surface. These modified functions then have an influence on the radar cross section (RCS) from contaminated sea surfaces. The bistatic RCS of the contaminated sea surface is then presented by comparison with a clean sea: results from a benchmark numerical model are presented and compared with a new semiempirical model using the geometric optics approximation and then the first-order smallslope approximation. [J1471]

"Soil Moisture Retrieval From Remotely Sensed Data: Neural Network Approach Versus Bayesian Method"

Neural network (NN) approaches and statistical methods, based on a Bayesian procedure, are applied and compared in soil moisture (SM) retrieval from remotely sensed data. The principles and the practical implementations of Bayesian procedures and NNs are briefly discussed in terms of the advantages and disadvantages of each. Experimental tests are carried out by using the same set of training and test data for each method. The methodologies have been applied to two sets of data to retrieve SM from bare soils and to verify their accuracy. One data set contains scatterometer and radiometer data acquired on a variety of agricultural fields in different polarizations, frequencies, and incidence angles. The other is made up of five experiments carried out with a C-band scatterometer on rough and smooth soils at different polarizations and incidence angles. There are significant similarities in the performance of each method; they both retrieve the same features and trends in the analyzed data sets. Algorithm performances change according to SM level and data configuration. The main difficulties are found in retrieving low SM values, and in this case, the error on estimates is reduced when the data with two polarizations or two incidence angles are inserted in the inversion procedure. One major difference between the methodologies is that the NN performance improves, with respect to the Bayesian method, when more inputs are presented as two polarizations or two incidence angles in the training phase. [J1472]

"Processing of Azimuth-Invariant Bistatic SAR Data Using the Range Doppler Algorithm"

This paper discusses bistatic synthetic aperture radar processing (complex image formation) using the Range Doppler Algorithm. The key step is to use an analytical form of the signal spectrum derived by the method of series reversion. The spectrum is used for secondary range compression (SRC), range cell migration correction, and azimuth compression. The algorithm is able to focus the azimuth-invariant bistatic configuration where the transmitter and receiver platforms are moving in parallel tracks with identical velocities. Moreover, the algorithm is able to handle reasonably high squints and wide apertures because SRC can be performed in the 2-D frequency domain. [J1473]

"Phase Unwrapping for SAR Interferometry-A Data Fusion Approach by Kalman Filtering"

This paper considers the problem of unwrapping the phase image obtained from a noisy interferometric synthetic aperture radar (InSAR) image. The implicit nonlinearity of the problem is reflected, as well as the drawbacks of this nonlinearity on the performance of phase unwrapping approaches. Some general concepts concerning basic estimation techniques are shortly reviewed. On this background, a Kalman filter-based data fusion approach to unwrap and simultaneously filter the phases of InSAR images is developed. The data fusion concept exploits phase information extracted from the complex interferogram rather than from the phase image and fuses that information with phase slope information extracted from the power spectral density of the interferogram. [J1474]

"High-Resolution Three-Dimensional Radar Imaging for Rapidly Spinning Targets"

A 3-D inverse synthetic aperture radar imaging method for rapidly spinning targets, i.e., a generalized Radon transform (GRT)-CLEAN algorithm, is proposed in this paper. The signal model is first changed into an equivalent high-speed turntable model after the compensation of the translational motion. Second, based on the relationship between the range profile variation of the spinning targets and the scatterers' positions, the GRT is utilized to estimate the scatterers' positions. Finally, combining the GRT with the modified CLEAN approach, the parameters of each scatterer and, thus, the 3-D image of the targets can be obtained. In addition to the development of the GRT-CLEAN algorithm, the estimation and compensation of the linear translational motion error in the imaging process is also considered in this paper. Good images yielded confirm the effectiveness of the GRT-CLEAN algorithm in the simulations. [J1475]

"Using C-Band Synthetic Aperture Radar Data to Monitor Forested Wetland Hydrology in Maryland's Coastal Plain, USA"

Hydrology (i.e., inundation and soil moisture) is the most important abiotic factor controlling wetland function and extent, and scientists predict that wetland hydrology can be significantly altered over relatively short timescales due to climate change and anthropogenic impact. Whereas broadscale hydrology is difficult to monitor in forested wetlands with ground-based and optical remote sensing methods, C-band synthetic aperture radar (SAR) systems have the potential to improve the capability to monitor forested wetland hydrology. In this study, we examined the use of Environmental Satellite Advanced SAR (C-HH and C-VV) data for monitoring levels of inundation and soil moisture throughout the year in a typical Mid-Atlantic floodplain and some of the main limitations inherent to C-band data (i.e., polarization and plant phenology) in this environment. The relationships between the backscatter coefficient and inundation, soil moisture, tree basal area, tree height, and forest canopy closure were examined. Significant differences in C-HH were found between forested areas of varying hydrology (0%-60% area inundated) throughout the year and in C-VV during the leaf-off season. As expected, C-HH SAR backscatter was better correlated with inundation and soil moisture than was C-VV SAR backscatter, and the correlations between both polarizations of backscatter and hydrology were stronger during the leaf-off season (C-HH leaf-off, leaf-on ; C-VV leaf-off, leaf-on ; all significant at level). Based on our findings, we concluded that the C-HH data are useful for monitoring hydrology beneath forest canopies throughout the year, whereas the C-VV data can be used during the leaf-off season. Our findings support previous studies that concluded that C-band imagery can be used to monitor forested wetland hydrology in large floodplains that are fully inundated. However, this study used detailed in situ measurements and demonstrated that C-band SAR data can also be used to monitor-forested wetland hydrology in smaller partially inundated floodplains, which are more common in the Mid-Atlantic. [J1476]

"Time Reversal Imaging by Adaptive Interference Canceling"

We develop the time reversal adaptive interference canceler (TRAIC) time reversal beamformer (TRBF), a new algorithm to detect and locate targets in rich scattering environments. It utilizes time reversal in two stages: (1) Anti-focusing: TRAIC time reverses and then reshapes the clutter backscatter to mitigate the clutter response; (2) Focusing: TRBF time reverses the residual backscatter to focus the radar image on the target. Laboratory experiments with electromagnetic radar data in a highly cluttered environment confirm the superiority of TRAIC-TRBF over conventional direct subtraction (DS) beamform imaging. [J1477]

"Measurement of Distance and Medium Velocity Using Frequency-Modulated Sound/Ultrasound"

The methods reported for the measurement of distance and medium velocity using ultrasound are based on the principles of pulse radar, pulse Doppler radar, and continuous- wave radar. In this paper, the use of frequency-modulated sonic/ultrasonic radiations for such measurements has been proposed. The required measurement setup has been described, and the mathematical model needed for extraction of distance/medium velocity from the electrical output signal has been developed. The proposed measurement setup has been implemented for distance measurement with commonly used ICs. [J1478]

"0.5- CMOS Implementation of Analog Heart-Rate Extraction With a Robust Peak Detector"

A robust high-accuracy analog-signal-processing 0.5-mum CMOS chip for real-time heart-rate (HR) extraction is presented. A novel peak-detector architecture is proposed and implemented to facilitate on-chip integration. The system is capable of processing electrocardiogram (ECG) signals with a peak-to-peak amplitude as low as 5 mV, without any prefiltering. Experimental results with prerecorded and real-time ECG signals have demonstrated the obtained R-R interval accuracy on the order of milliseconds. The system was also used to successfully extract HR intervals with Doppler radar. Such a system may significantly reduce ADC resolution and sampling speed requirements while providing high immunity to noise and DC offset drift. [J1479]

"IP multimedia subsystems in 3GPP and 3GPP2: overview and scalability issues"

The Internet has experienced tremendous expansion in the past several years. Demands for IP multimedia services are emerging. The third-generation (3G) wireless networks aim to support mobile users with numerous Internet services. 3G standards organizations are developing IP multimedia subsystems (IMS) to achieve seamless integration between Internet and 3G networks. Moreover, the collaboration between IETF, 3GPP, and 3GPP2 is essential to the development of IMS for next-generation networks. This article first provides an overview of 3GPP and 3GPP2 IMS and illustrates the IMS requirements, architectures, and functional models. We then discuss potential scalability issues in IMS. This article provides guidance for constructing a robust and scalable IMS. [J1480]

"Millimeter-Wave-Radar Sensor Based on a Transceiver Array for Automotive Applications"

This paper describes a new radar sensor architecture comprising an array of transceiver modules. Target applications of the sensor are automotive driver assistance systems. In conjunction with a monolithic integration of each transceiver, the concept offers the possibility for a cost-effective realization of digital-beamforming radar sensors at millimeter-wave frequencies. A modulation sequence is investigated based on simultaneously transmitted frequency-modulated continuous-wave signals, which are separated by frequency multiplexing. Appropriate signal processing for the estimation of range, speed, and azimuth angle in multiple object situations is presented. Experimental results with an eight-channel radar sensor in the 76-77-GHz frequency band are presented, which demonstrate the feasibility of the proposed architecture and show the performance of the modulation sequence and signal processing. [J1481]

"An Efficient Intermodulation Product Computing Technique for Broadband Active Transmit Systems"

The determination of intermodulation products is an ever pervasive problem to the radar and satellite community-its eminence will continue to manifest itself as data rates increase, as transmitters are required to handle increasing numbers of multiple carriers, and as amplifiers are pushed to operate closer to their nonlinear regions (to circumvent the need of adding the extra weight and cost of a more linear amplifier). To study the intermodulation effects, fast Fourier transform (FFT)-based techniques are often employed. By definition, defines the frequency resolution for the discrete Fourier transform (DFT). It is typically desired to design to be as small as possible to allow for a very fine frequency resolution. Doing this requires that be minimized and/or be selected as large as possible. Minimizing has its pitfalls since high-order harmonics may violate the Nyquist criteria. Selecting to be as large as possible introduces unreasonably long simulation times. This may be the case when large values of are very near or exceed the maximum allowable array size of a digital computer. Breaking this nexus is the focus of this paper, which introduces a computationally efficient technique that will allow the frequency and amplitude of the intermodulation terms to be precisely computed. [J1482]

"A Systematic Construction for Radar Arrays"

The radar array problem arises from the need to design frequency hopping sequences with small out-of-phase autocorrelations. It assumes the reflected signals have negligible Doppler shifts, so the correlations are calculated along the time axis only. In this correspondence, a systematic construction for radar arrays is provided by means of homogeneous uniform difference matrices. A systematic construction for properly centered permutation matrices, a special kind of homogeneous uniform difference matrices, is also provided, which partially solves the open problems posed by Zhang and Tu. [J1483]

"Evaluation of a Near-Field Monostatic-to-Bistatic Equivalence Theorem"

This paper presents the results of an investigation to quantitatively determine the limits of Falconer's monostatic-to-bistatic equivalence theorem (MBET). Falconer developed two extensions to Kell's MBET: one that is applicable to near-zone data and one that is valid in both the near- and far-zone regions. This paper encompassed collecting and analyzing both monostatic and bistatic radar cross-section data for perfect electrically conducting objects. Specifically, the authors analyzed the effects of varying the transmission frequency, scattering object complexity, and receiver bistatic angle. Objects ranged in geometric complexity from simple canonical objects to multifaceted shapes that produce multiple reflections. Empirical data collected in the far zone were compared with the analytical predictions produced by a commercially available method-of-moment (MoM) code. The code was run at X-band through K-band frequencies for a comparison with the measured data. The empirical bistatic data were then compared with the estimate produced by the MBET to ascertain the region in which the MBET approximation is applicable. Finally, the MoM code was used to produce near-field scattering predictions to facilitate the evaluation of Falconer's near-field MBET. It is shown that the complexity of the scatterer restricts the region of validity for the MBET, where shadowing and multipath interactions prevail. The disparity between the MBET accuracies for the different test objects used clearly illustrates this point. [J1484]

"Ultra-thin tunable microwave absorber using liquid crystals"

A dynamically adaptive radar absorber is described which is based on a periodic array of microstrip patches that are printed on a 500 mum-thick liquid crystal substrate. The measured reflectivity of the structure is less than -38 dB with a 200 MHz -10 dB bandwidth at 10.19 GHz when a +4 DC bias is applied. It is shown that a 34 dB reduction in signal loss occurs when the bias voltage is increased to 20 V. [J1485]

"Predicted Detection Performance of MIMO Radar"

It has been shown that multiple-input multiple-output (MIMO) radar systems can improve target detection performance significantly by exploiting the spatial diversity gain. We introduce the system model in which the radar target is composed of a finite number of small scatterers and derive the formula to evaluate the theoretical probability of detection for the system having an arbitrary array-target configuration. The results can be used to predict the detection performance of the actual MIMO radar without time-consuming simulations. [J1486]

"A Note on Image Restoration Using and MSE"

Image restoration necessitates the choice of a regularization parameter that controls the trade-off between fidelity to the blurred noisy observed image and the smoothness of the restored image. The choice of this parameter for which several estimators have been proposed is crucial for the quality of the restored image. In this letter, two estimators for choosing the regularization parameter are proposed. One is a simple closed-form approximation to the minimum of the selection criterion, and the other is an approximation to the minimum of a mean squared error (MSE)-based criterion. [J1487]

"Maximum Position Alignment Method for Noisy High-Resolution Radar Target Classification"

In this paper, the alignment of noisy high-resolution radar signals using the maximum position method is studied. The relationship between the shift estimation and the signal-to-noise ratio is considered. As a result, two analytical expressions are obtained that approximate the root-mean-square error of the difference in the shift estimation with and without noise. These two expressions allow us to improve the understanding of the sensitivity to noise of the Maximum Position alignment method. [J1488]

"Authors' Reply to Comments by Takuya Sakamoto, Shouhei Kidera, and Toru Sato on “Seabed Algorithm and Comments on ‘Modeling and Migration of 2-D Georadar Data: A Stationary Phase Approach’”"

This article addresses the comments of Sakamato et al. on Greenhalgh et al.'s "Modeling and migration of 2-D georadar data: A stationary phase approach". Here, Greenhalgh et al. emphasizes the comprehensiveness of their approach over Sakamato et al.'s SEABED algorithm. [J1489]

"Bistatic Spotlight SAR Processing Using the Frequency-Scaling Algorithm"

This letter derives the bistatic point target spectrum for the translational invariant case. Based on the derived spectrum and the linear approximation of the bistatic range cell migration factor, a bistatic frequency-scaling algorithm (FSA) is proposed for spotlight synthetic aperture radar data processing. This algorithm leads to a very precise and efficient processing since it performs the focusing in the frequency domain and no interpolation is required in the whole processing chain. In addition, it is shown that the case considered in the monostatic FSA is a specialization of the more general one considered in this letter. Finally, simulation results are provided to illustrate the validity of the presented approach. [J1490]

"Estimating the Breast Surface Using UWB Microwave Monostatic Backscatter Measurements"

This paper presents an algorithm for estimating the location of the breast surface from scattered ultrawideband (UWB) microwave signals recorded across an antenna array. Knowing the location of the breast surface can improve imaging performance if incorporated as a priori information into recently proposed microwave imaging algorithms. These techniques transmit low-power microwaves into the breast using an antenna array, which in turn measures the scattered microwave signals for the purpose of detecting anomalies or changes in the dielectric properties of breast tissue. Our proposed surface identification algorithm consists of three procedures, the first of which estimates points on the breast surface given channels of measured microwave backscatter data. The second procedure applies interpolation and extrapolation to these points to generate points that are approximately uniformly distributed over the breast surface, while the third procedure uses these points to generate a 3-D estimated breast surface. Numerical as well as experimental tests indicate that the maximum absolute error in the estimated surface generated by the algorithm is on the order of several millimeters. An error analysis conducted for a basic microwave radar imaging algorithm (least-squares narrowband beamforming) indicates that this level of error is acceptable. A key advantage of the algorithm is that it uses the same measured signals that are used for UWB microwave imaging, thereby minimizing patient scan time and avoiding the need for additional hardware. [J1491]

"Sampling and Sampling Rate Conversion of Band Limited Signals in the Fractional Fourier

Transform Domain"

The fractional Fourier transform (FRFT) has become a very active area in signal processing community in recent years, with many applications in radar, communication, information security, etc., This study carefully investigates the sampling of a continuous-time band limited signal to obtain its discrete-time version, as well as sampling rate conversion, for the FRFT. Firstly, based on product theorem for the FRFT, the sampling theorems and reconstruction formulas are derived, which explain how to sample a continuous-time signal to obtain its discrete-time version for band limited signals in the fractional Fourier domain. Secondly, the formulas and significance of decimation and interpolation are studied in the fractional Fourier domain. Using the results, the sampling rate conversion theory for the FRFT with a rational fraction as conversion factor is deduced, which illustrates how to sample the discrete-time version without aliasing. The theorems proposed in this study are the generalizations of the conventional versions for the Fourier transform. Finally, the theory introduced in this paper is validated by simulations. [J1492]

"Pine Forest Height Inversion Using Single-Pass X-Band PolInSAR Data"

A sparse pine forest is investigated at X-band on a single-pass polarimetric synthetic aperture radar interferometry (PolInSAR) data set using HH and HV channels. These first preliminary results show that the associated phase centers present a significant vertical separation (about 6 m) allowed by penetration through gaps in the canopy. Forest parameter inversion using the random volume over ground (RVoG) model is evaluated and adapted at this frequency. The forest height can be retrieved accurately by supposing a high mean extinction coefficient (around 1.6 (dB/m). The penetration depth is estimated to be around 4 m, based on the forest height ground measurements. Finally, a time-frequency analysis using a sublook decomposition is performed to increase the vertical separation of the polarimetric phase centers. As a consequence, RVoG-inversion performance is improved, and a penetration depth that is in better accordance with a previous work (of the order of 2 m) is found. This paper has shown that the height inversion of a pine forest was possible using PolInSAR X-band data and that the performance was more dependent on the forest density than at lower frequencies. [J1493]

"Statistical Properties of the Estimated Degree of Polarization"

We derive important and useful new statistical properties of the estimated degree of polarization in the two-dimensional case. We find its distribution function and show how it may be used to construct confidence intervals. We also find an expression for any moment of the distribution, and derive an exact unbiasing formula for the estimator of the squared coefficient. Further we discuss a test for partial polarization. Our statistical analyses enable identification of elliptical polarization for an ultra low frequency wave in the solar magnetic field. [J1494]

"Dosimetric Assessment of Simultaneous Exposure to ELF Electric and Magnetic Fields"

In the low-frequency range, both electric and magnetic fields interact with biological tissue by inducing intracorporal electric current densities, although ruled by different physical laws and, hence, with different intracorporal orientation and pathways. Presently, standards require a separate assessment of electric and magnetic fields even in the case of simultaneous exposure and, hence, ignore the superposition of intracorporal current densities. Numerical simulations with the Visible Man model show that this can lead to underestimating current densities in the central nervous system (CNS) by up to 29%. While the superposed electric current densities in the CNS still meet the basic restrictions, the situation changes if a fetus with its own CNS requires the same level of protection. When the compliance volume is extended to the trunk, the reference-level electric-field exposure exceeds the basic restrictions by 38%. Depending on the kind of summation of the vectorial contributions, simultaneous exposure to the 50 Hz-5 kV/m electric field and 100-T magnetic field may lead to a 2.1-fold to 2.6-fold excess of the basic restriction. While this does not prove noncompliance, it indicates that fetal CNS exposure modeling is needed for clarification. [J1495]

"Covariance Structure Maximum-Likelihood Estimates in Compound Gaussian Noise: Existence and Algorithm Analysis"

Recently, a new adaptive scheme [Conte (1995), Gini (1997)] has been introduced for covariance structure matrix estimation in the context of adaptive radar detection under non-Gaussian noise. This latter has been modeled by compound-Gaussian noise, which is the product cof the square root of a positive unknown variable tau (deterministic or random) and an independent Gaussian vector x, c=radictaux. Because of the implicit algebraic structure of the equation to solve, we called the corresponding solution, the fixed point (FP) estimate. When tau is assumed deterministic and unknown, the FP is the exact maximum-likelihood (ML) estimate of the noise covariance structure, while when tau is a positive random variable, the FP is an approximate maximum

likelihood (AML). This estimate has been already used for its excellent statistical properties without proofs of its existence and uniqueness. The major contribution of this paper is to fill these gaps. Our derivation is based on some likelihood functions general properties like homogeneity and can be easily adapted to other recursive contexts. Moreover, the corresponding iterative algorithm used for the FP estimate practical determination is also analyzed and we show the convergence of this recursive scheme, ensured whatever the initialization. [J1496]

"Time-Domain Optimized Near-Field Estimator for Ultrasound Imaging: Initial Development and Results"

For nearly four decades, adaptive beamforming (ABF) algorithms have been applied in RADAR and SONAR signal processing. These algorithms reduce the contribution of undesired off-axis signals while maintaining a desired response along a specific look direction. Typically, higher resolution and contrast is attainable using adaptive beamforming at the price of an increased computational load. In this paper, we describe a novel ABF designed for medical ultrasound, named the time-domain optimized near-field estimator (TONE). We performed a series of simulations using synthetic ultrasound data to test the performance of this algorithm and compared it to conventional, data independent, delay and sum beamforming (CBF) method. We also performed experiments using a Philips SONOS 5500 phased array imaging system. CBF was applied using the default parameters of the Philips scanner, whereas TONE was applied on per channel, unfocused data using an unfocused transmit beam. TONE images were reconstructed at a sampling of 67 m laterally and 19 m axially. The results obtained for a series of five 20-m wires in a water tank show a significant improvement in spatial resolution when compared to CBF. We also analyzed the performance of TONE as a function of speed of sound errors and array sparsity, finding it robust to both. [J1497]

"Range Compression and Waveform Optimization for MIMO Radar: A CramЙr-Rao Bound Based Study"

A multi-input multi-output (MIMO) radar system, unlike standard phased-array radar, can transmit via its antennas multiple probing signals that may be correlated or uncorrelated with each other. This waveform diversity offered by MIMO radar enables superior capabilities compared with a standard phased-array radar. One of the common practices in radar has been range compression. We first address the question of ldquoto compress or not to compressrdquo by considering both the Cramer-Rao bound (CRB) and the sufficient statistic for parameter estimation. Next, we consider MIMO radar waveform optimization for parameter estimation for the general case of multiple targets in the presence of spatially colored interference and noise. We optimize the probing signal vector of a MIMO radar system by considering several design criteria, including minimizing the trace, determinant, and the largest eigenvalue of the CRB matrix. We also consider waveform optimization by minimizing the CRB of one of the target angles only or one of the target amplitudes only. Numerical examples are provided to demonstrate the effectiveness of the approaches we consider herein. [J1498]

"Breast Tumor Characterization Based on Ultrawideband Microwave Backscatter"

Characterization of architectural tissue features such as the shape, margin, and size of a suspicious lesion is commonly performed in conjunction with medical imaging to provide clues about the nature of an abnormality. In this paper, we numerically investigate the feasibility of using multichannel microwave backscatter in the 1-11 GHz band to classify the salient features of a dielectric target. We consider targets with three shape characteristics: smooth, microlobulated, and spiculated; and four size categories ranging from 0.5 to 2 cm in diameter. The numerical target constructs are based on Gaussian random spheres allowing for moderate shape irregularities. We perform shape and size classification for a range of signal-to-noise ratios (SNRs) to demonstrate the potential for tumor characterization based on ultrawideband (UWB) microwave backscatter. We approach classification with two basis selection methods from the literature: local discriminant bases and principal component analysis. Using these methods, we construct linear classifiers where a subset of the bases expansion vectors are the input features and we evaluate the average rate of correct classification as a performance measure. We demonstrate that for 10 dB SNR, the target size is very reliably classified with over 97% accuracy averaged over 360 targets; target shape is classified with over 70% accuracy. The relationship between the SNR of the test data and classifier performance is also explored. The results of this study are very encouraging and suggest that both shape and size characteristics of a dielectric target can be classified directly from its UWB backscatter. Hence, characterization can easily be performed in conjunction with UWB radar-based breast cancer detection without requiring any special hardware or additional data collection. [J1499]

"Multitarget Detection and Estimation Based on Passive Multilateral TDOAs of Transient Signals"

A modified deterministic annealing expectation maximization (MDAEM) algorithm has been proposed [D. Carevic, ldquoAutomatic estimation of multiple target positions and velocities using passive TDOA measurements of

transients,rdquo IEEE Transactions on Signal Processing, vol. 55, no. 2, pp. 424-436, 2007] for the estimation of the motion parameters of multiple targets moving in cluttered three-dimensional (3D) underwater environments. In many situations, the number of targets in the measurements batch is not known, and the MDAEM algorithm is run for an inexact (guessed) number of the motion models, where, usually, the guessed number of models is larger than the true number of targets. This correspondence describes a detection procedure that determines which of the motion models estimated by the algorithm are related to the true targets in the measurements batch. [J1500]

"Multidimensional Waveform Encoding: A New Digital Beamforming Technique for Synthetic Aperture Radar Remote Sensing"

This paper introduces the innovative concept of multidimensional waveform encoding for spaceborne synthetic aperture radar (SAR). The combination of this technique with digital beamforming on receive enables a new generation of SAR systems with improved performance and flexible imaging capabilities. Examples are high-resolution wide-swath radar imaging with compact antennas, enhanced sensitivity for applications like alongtrack interferometry and moving object indication, and the implementation of hybrid SAR imaging modes that are well suited to satisfy hitherto incompatible user requirements. Implementation-specific issues are discussed and performance examples demonstrate the potential of the new technique for different remote sensing applications. [J1501]

"Supervised Classification and Estimation of Hydrometeors From C-Band Dual-Polarized Radars: A Bayesian Approach"

In this paper, a Bayesian statistical approach for supervised classification and estimation of hydrometeors, using a C-band polarimetric radar, is presented and discussed. The Bayesian Radar Algorithm for Hydrometeor Classification at C-band (BRAHCC) is supervised by a backscattering microphysical model, aimed at representing ten different hydrometeor classes in water, ice, and mixed phase. The expected error budget is evaluated by means of contingency tables on the basis of C-band radar noisy and attenuated synthetic data. Its accuracy is better than that obtained from a previously developed fuzzy logic C-band classification algorithm. As a second step of the overall retrieval algorithm, a multivariate regression is adopted to derive water content statistical estimators, exploiting simulated polarimetric radar data for each hydrometeor class. The BRAHCC methodology is then applied to a convective hail event, observed by two C-band dual-polarized radars in a network configuration. The hydrometeor classification along the line of sight, connecting the two C-band radars, is performed using the BRAHCC applied to path-attenuation-corrected data. Qualitative results are consistent with those derived from the fuzzy logic algorithm. Hydrometeor water content temporal evolution is tracked along the radar line of sight. Hail vertical occurrence is derived and compared with an empirical hail detection index applied along the radar connection line during the whole event. [J1502]

"MIMO Radar Space-Time Adaptive Processing Using Prolate Spheroidal Wave Functions"

In the traditional transmitting beamforming radar system, the transmitting antennas send coherent waveforms which form a highly focused beam. In the multiple-input multiple-output (MIMO) radar system, the transmitter sends noncoherent (possibly orthogonal) broad (possibly omnidirectional) waveforms. These waveforms can be extracted at the receiver by a matched filterbank. The extracted signals can be used to obtain more diversity or to improve the spatial resolution for clutter. This paper focuses on space-time adaptive processing (STAP) for MIMO radar systems which improves the spatial resolution for clutter. With a slight modification, STAP methods developed originally for the single-input multiple-output (SIMO) radar (conventional radar) can also be used in MIMO radar. However, in the MIMO radar, the rank of the jammer-and-clutter subspace becomes very large, especially the jammer subspace. It affects both the complexity and the convergence of the STAP algorithm. In this paper, the clutter space and its rank in the MIMO radar are explored. By using the geometry of the problem rather than data, the clutter subspace can be represented using prolate spheroidal wave functions (PSWF). A new STAP algorithm is also proposed. It computes the clutter space using the PSWF and utilizes the block-diagonal property of the jammer covariance matrix. Because of fully utilizing the geometry and the structure of the covariance matrix, the method has very good SINR performance and low computational complexity. [J1503]

"Using the Phase Change of a Reflected Microwave to Detect a Human Subject Behind a Barrier"

In a pulsed radar system, the amplitude and sign of the echo from a particular target will depend on the phase of the echo signal relative to that of the local oscillator signal. If the wavelength of the radar signal is very short, the phase of the echo can change greatly if the target moves even slightly. Based on this physical behavior, the pulsed radar system can serve as a life-detection system to detect a human subject's movements, which include breathing and heartbeat. In this paper, a pulsed microwave life-detection system was developed from a pulsed

training radar system to successfully detect the presence of human subjects behind a simulated earthquake rubble wall. The sampled echo signals from the background noise, a dummy, and a female human subject are presented directly in the time domain without being transferred into the frequency domain, differentiating this work from recent works by other authors. Furthermore, we also demonstrate several superiorities of a pulsed system over and above the original continuous-wave approach with the experimental results. [J1504]

"Efficient Subspace-Based Estimator for Localization of Multiple Incoherently Distributed Sources"

In this paper, a new subspace-based algorithm for parametric estimation of angular parameters of multiple incoherently distributed sources is proposed. This approach consists of using the subspace principle without any eigendecomposition of the covariance matrix, so that it does not require the knowledge of the effective dimension of the pseudosignal subspace, and therefore the main difficulty of the existing subspace estimators can be avoided. The proposed idea relies on the use of the property of the inverse of the covariance matrix to exploit approximately the orthogonality property between column vectors of the noise-free covariance matrix and the sample pseudonoise subspace. The resulting estimator can be considered as a generalization of the Pisarenko's extended version of Capon's estimator from the case of point sources to the case of incoherently distributed sources. Theoretical expressions are derived for the variance and the bias of the proposed estimator due to finite sample effect. Compared with other known methods with comparable complexity, the proposed algorithm exhibits a better estimation performance, especially for close source separation, for large angular spread and for low signal-to-noise ratio. [J1505]

"Design of Frequency Invariant Beamformers for Broadband Arrays"

A new class of broadband arrays with frequency invariant beam pattern is proposed. By suitable substitutions, the beam pattern of a continuous sensor array can be regarded as the Fourier transform of its spatial and temporal parameters. For the design of practical discrete sensor arrays, it can be regarded as an approximation to the continuous sensor case and a simple design method is provided, which can be applied to linear, rectangular and cubic broadband arrays. [J1506]

"Improving Coherence of Complex Image Pairs Obtained by Along-Track Bistatic SARs Using Range-Azimuth Prefiltering"

An along-track interferometric synthetic aperture radar (SAR) can be used for ground moving target indication (GMTI) by comparing two SAR images obtained at different observation times. Different geometries of the two observations bring the decorrelation noise, which will degrade the detection performance. For bistatic SARs, the decorrelation theory is quite different from that for monostatic ones. This paper deals with the coherence between two complex SAR images formed by two along-track bistatic SARs with different baseline lengths. Using the single scattering model, the coherence between the two echoes collected by the two receivers is investigated, and the full-coherence conditions are derived. Then, a new method based on range-azimuth prefiltering is proposed to improve the coherence of complex image pairs. As the precise prefiltering is complicated, its three approximate implementations are given. The effects of prefiltering on SAR images are also analyzed. Finally, simulation results validate the effectiveness of the proposed method. [J1507]

"Model-Associated Forest Parameter Retrieval Using VHF SAR Data at the Individual Tree Level"

A simple statistical extension at the individual tree level for an earlier-developed very high frequency forest backscatter model is proposed. This extended model treats trunk volumes as random quantities. A concept of random forest reflection coefficient is also introduced to characterize radar returns from individual trees. Based on the extended model, a set of algorithms for estimating the mean trunk (stem) volume from synthetic aperture radar data at the individual tree level is developed assuming that the areal tree density is known. The algorithms are specified for different scenarios related to a prioriinformation on parameters of statistical distributions for the trunk volume and fluctuations of the forest reflection coefficient. An approximate lower bound on the standard deviation in the unbiased estimation of the mean trunk (stem) volume is proposed. This bound can be readily obtained by means of computer simulation for any specified statistical distribution for the trunk volume and fluctuations of the forest reflection coefficient. Performance analysis for the proposed algorithms is numerically performed by means of Monte Carlo simulation for a variety of scenarios. This analysis has shown that the algorithms provide nearly unbiased and efficient estimates, and the proposed lower bound is a very accurate approximation. The results of the study have demonstrated that the approach and methods developed in this paper suggest promising solutions in accurate forest parameter retrieval. [J1508]

"Vegetation Mapping for Landmine Detection Using Long-Wave Hyperspectral Imagery"

We develop a vegetation mapping method using long-wave hyperspectral imagery and apply it to landmine

detection. The novel aspect of the method is that it makes use of emissivity skewness. The main purpose of vegetation detection for mine detection is to minimize false alarms. Vegetation, such as round bushes, may be mistaken as mines by mine detection algorithms, particularly in synthetic aperture radar (SAR) imagery. We employ an unsupervised vegetation detection algorithm that exploits statistics of emissivity spectra of vegetation in the long-wave infrared spectrum for identification. This information is incorporated into a Choquet integral-based fusion structure, which fuses detector outputs from hyperspectral imagery and SAR imagery. Vegetation mapping is shown to improve mine detection results over a variety of images and fusion models. [J1509]

"Passive Source Localization Using Time Differences of Arrival and Gain Ratios of Arrival"

A source signal will be subject to different amounts of time-delay as well as attenuation when it reaches a number of spatially separated sensors. Both time-delay and attenuation are dependent on the distance between the source and the receivers. This paper performs a fundamental investigation of whether the gain ratios of arrival (GROAs), defined here as the ratio of the received signal amplitudes at the referenced sensor to the other sensors, can be utilized in conjunction with the time differences of arrival (TDOAs) to improve the source localization accuracy. We begin with a Gaussian random signal model and derive the Cramer-Rao lower bound (CRLB) of a source location estimate based on both GROAs and TDOAs. Our conclusion is that the improvement from GROAs increases when the factor c/omegaoincreases, where c is the signal propagation speed and omegaois the signal bandwidth. The paper proceeds to develop an algebraic closed-form solution for the source location using GROAs and TDOAs. The algebraic solution is proved theoretically to reach the CRLB accuracy under the Gaussian data model. Numerical simulations are included to support and corroborate the theoretical developments. [J1510]

"Bistatic Synthetic Aperture Radar Imaging for Arbitrary Flight Trajectories"

In this paper, we present an analytic, filtered backprojection (FBP) type inversion method for bistatic synthetic aperture radar (BISAR). We consider a BISAR system where a scene of interest is illuminated by electromagnetic waves that are transmitted, at known times, from positions along an arbitrary, but known, flight trajectory and the scattered waves are measured from positions along a different flight trajectory which is also arbitrary, but known. We assume a single-scattering model for the radar data, and we assume that the ground topography is known but not necessarily flat. We use microlocal analysis to develop the FBP-type reconstruction method. We analyze the computational complexity of the numerical implementation of the method and present numerical simulations to demonstrate its performance. [J1511]

"Minimizing Radiation Leakage from Microwave Ovens"

In this article, an effective solution to minimize radiation leakage from microwave ovens, a microwave "choke" is discussed. This greatly simplified choke design was recommended to the manufacturer, was built, and was tested for functionality. It exhibited the very low leakage sought to meet health and safety considerations. This choke design was found to be economical to manufacture, very reliable, and very tolerant of the spacing between door and oven chamber. The choke was adopted for oven manufacture since it addressed feasibility, safety issues, and economy. In current microwave ovens, the choke is hidden from view by an opaque plastic strip near the oven cavity periphery. The strip can be easily cleaned to remove food spillage that would inhibit choke effectiveness. [J1512]

"Suppression of Clutter Residue in Weather Radar Reveals Birds' Corridors Over Urban Area"

An adaptive spectral technique for ground clutter and noise suppression in weather radar echoes is presented. This technique detects weak echoes that are masked by the residuals from ground clutter. The technique is demonstrated on two clear air cases observed with Doppler weather radar. After adaptive suppression of ground clutter and its residue, features appear over the Oklahoma City urban area where otherwise none could be seen. These are interpreted as birds' corridors between two lakes and along a river. [J1513]

"The Adaptive Coherence Estimator is the Generalized Likelihood Ratio Test for a Class of Heterogeneous Environments"

The adaptive coherence estimator (ACE) is known to be the generalized likelihood ratio test (GLRT) in partially homogeneous environments, i.e., when the covariance matrix Msof the secondary data is proportional to the covariance matrix Mpof the vector under test (or Ms= gamma/Mp). In this letter, we show that ACE is indeed the GLRT for a broader class of nonhomogeneous environments, more precisely when Msis a random matrix, with inverse complex Wishart prior distribution whose mean only is proportional to Mp. Furthermore, we prove that, for this class of heterogeneous environments, the ACE detector satisfies the constant false alarm rate (CFAR)

property with respect to gamma and Mp. [J1514]

"Hybrid Distributed Instrumentation Network for Integrating Meteorological Sensors Applied to Modeling RF Propagation Impairments"

Rainfall rate is the main cause of fades in the frequency bands above 10 GHz. To optimize the planning of satellite and terrestrial radio communication systems operating on these frequency bands, it is essential to have a detailed knowledge of the temporal and spatial distributions of the rainfall rate. For this reason, it is necessary to develop experimental networks, which provide adequate data to study, prevent, and compensate the rain fade. In this paper, an experimental instrumentation network is presented. This network comprises weather stations that are capable of measuring rainfall rate, temperature, and humidity; a weather radar; and three radio links. This paper first introduces the rationale and the state of the art in meteorological sensors and describes the experimental network for automatic data acquisition as a distributed process system. The design of the experimental network is explained in detail. Finally, the interest in millimeter wavelength for broadband applications is outlined, and some research lines from the collected data are presented. [J1515]

"Three-Dimensional Wideband Beamforming for Imaging Through a Single Wall"

Through-the-wall imaging and urban sensing is an emerging area of research and development. The incorporation of the effects of signal propagation through wall material in producing an indoor image is important for reliable through-the-wall mission operations. We have previously analyzed wall effects, such as refraction and change in propagation speed, and designed a wideband beamformer for 2D imaging using line arrays. In this letter, we extend the analysis to 3D imaging via delay-and-sum beamforming in the presence of a single uniform wall. The third dimension provides valuable information on target heights that can be used for enhancing target discrimination/identification. Supporting simulation results are provided. [J1516]

"Polarimetric Detection of Targets in Heavy Inhomogeneous Clutter"

Polarization diversity has proved to be a useful tool for radar detection, especially when discrimination by Doppler effect is not possible. In this paper, we address the problem of improving the performance of polarimetric detectors for targets in heavy inhomogeneous clutter. First, we introduce a new polarimetric radar model that includes the realistic dependence of the clutter reflections on the transmitted signal. Then, we develop a polarimetric detection test that is robust to inhomogeneous clutter. We run this polarimetric test against synthetic and real data to assess its performance in comparison with existing polarimetric detectors. Finally, we propose a polarimetric waveform-design algorithm to further improve the target-detection performance. A numerical analysis is presented to demonstrate the potential performance improvement that can be achieved with this algorithm. [J1517]

"Performance Analysis of GPS Receivers in Non-Gaussian Noise Incorporating Precorrelation Filter and Sampling Rate"

Global positioning system (GPS) receivers find growing applications in indoor and outdoor communication environments, including urban and rural areas. Interference and noise sources for GPS receivers may assume Gaussian or non-Gaussian distributions. The GPS receiver performance under Gaussian additive noise has been studied. Non-Gaussian noise may equally contaminate the GPS satellite signals and disturb the receiver delay lock loops (DLL), producing significant tracking errors. These sources include impulsive noise, ultra-wideband (UWB) signals, and impulse and noise radar signals for target tracking and indoor imaging applications. This paper considers non-Gaussian noise of finite variance and examines its effect on the discriminator outputs for the commercial GPS receiver that uses the coarse acquisition (C/A) code. The correlator noise output components are produced from the correlation between the noise sequence and the early, late, and punctual reference C/A code. Due to the long time averaging, which is characteristic of the GPS correlation loops, these components assume Gaussian distributions. The discriminator tracking error variance is derived, incorporating the effect of noise, the front-end precorrelation filter, and the sampling rate. [J1518]

"On the Interplay Between the Equipment Under Test and TEM Cells"

In all applications of the gigahertz transverse electromagnetic (GTEM) cell, there is an interplay between the equipment under test (EUT) and the cell reflecting metal walls, as represented by images of the EUT. Moreover, owing to the multiple reflections within the cell and to its tapering structure, the phenomenon of illumination and reillumination of the EUT can hardly be avoided. These problems, known as reactive effects of the cell, are investigated in this paper. A simple new approach for an efficient investigation of the interactions between the EUT and the cell is provided. Closed-form expressions for the reflection coefficient, the relative deviation in field,

and the relative error in the induced current caused by the reactive effect of the cell are derived. Each of these expressions encompasses both the mutual influence of the EUT's radar cross section (RCS) and the reactive effects of the cell. It is shown that depending on the frequency-dependent phase factor ejpsi, strong and weak test conditions may occur since the overall incident field will exhibit maxima and minima. Hence, evidence showing that the total incident field impinging on the EUT generally deviates from the primary excited TEM field is provided. Moreover, the relative deviation in the field and the relative error in the induced current are quantified. Finally, the frequency dependence of the well-known one-third-rule of thumb is demonstrated. [J1519]

"Through-Wall Imaging With a 3-D UWB SAR Algorithm"

Ultra-wideband (UWB) radar systems become more and more important for material penetrating and imaging applications. Many conventional UWB signal processing algorithms for image generation are commonly based on migrations techniques which are not optimal in terms of object identification capability and calculation time. Thus, a surface reconstructing imaging algorithm has been implemented and verified by real radar data. It offers two crucial advantages with respect to the conventional algorithms: an extensive reduction of the calculation time and the ability to identify targets by the shape of the object. Several examples are given demonstrating the efficiency of this approach. It is based on a preselection of the received C-scan yielding the quasi-wavefronts of the object. [J1520]

"Lessons Learned on Five Large-Scale System Developments"

System planners, architects, and developers often make the same mistakes on grand scales, but we usually stay with familiar approaches, especially under deadline pressures. Engineers and managers embrace the concept of process improvement, yet they rarely take time (or have the privilege of taking the time) to consider how something that has worked in the past could be improved. It is equally rare for them to make the effort to change plans and processes to benefit from mistakes. This article explores several high-level lessons learned, mostly on large system developments that were not always successful. The lessons concern project difficulties caused by thinking that's stuck in the present; excessive faith in code reuse; failure to see the big picture; absence of independent failure analysis; and estimation processes driven by fear and ignorance. [J1521]

"Quickest Detection and Tracking of Spawning Targets Using Monopulse Radar Channel Signals"

Recent advances have been reported in detecting and estimating the location of more than one target within a single monopulse radar beam. Successful tracking of those targets has been achieved with the aid of nonlinear filters that approximate the targets' states' conditional pdf, bypassing the measurement extraction stage, and operating directly on the monopulse sum/difference data, i.e., without measurement extraction. The problem of detecting a target spawn will be tackled in this paper. Particle filters will be employed as nonlinear tracking filters to approximate the posterior probability densities of the targets' states under different hypotheses of the number of targets, which in turn can be used to evaluate the likelihood ratio between two different hypotheses at subsequent time steps. Ultimately, a quickest detection procedure based on sequential processing of the likelihood ratios will be used to decide on a change in the underlying target model as an indication of a newly spawning target. Radar signal processing, data association, and target tracking are handled simultaneously. [J1522]

"Adaptive Polarized Waveform Design for Target Tracking Based on Sequential Bayesian Inference"

In this paper, we develop an adaptive waveform design method for target tracking under a framework of sequential Bayesian inference. We employ polarization diversity to improve the tracking accuracy of a target in the presence of clutter. We use an array of electromagnetic (EM) vector sensors to fully exploit the polarization information of the reflected signal. We apply a sequential Monte Carlo method to track the target parameters, including target position, velocity, and scattering coefficients. This method has the advantage of being able to handle nonlinear and non-Gaussian state and measurement models. The measurements are the output of the sensor array; hence, the information about both the target and its environment is incorporated in the tracking process. We design a new criterion for selecting the optimal waveform one-step ahead based on a recursion of the posterior Cramer-Rao bound. We also derive an algorithm using Monte Carlo integration to compute this criterion and a suboptimal method that reduces the computation cost. Numerical examples demonstrate both the performance of the proposed tracking method and the advantage of the adaptive waveform design scheme. [J1523]

"Multilayered 3D LiDAR Image Construction Using Spatial Models in a Bayesian Framework"

Standard 3D imaging systems process only a single return at each pixel from an assumed single opaque surface.

However, there are situations when the laser return consists of multiple peaks due to the footprint of the beam impinging on a target with surfaces distributed in depth or with semitransparent surfaces. If all these returns are processed, a more informative multilayered 3D image is created. We propose a unified theory of pixel processing for Lidar data using a Bayesian approach that incorporates spatial constraints through a Markov Random Field with a Potts prior model. This allows us to model uncertainty about the underlying spatial process. To palliate some inherent deficiencies of this prior model, we also introduce two proposal distributions, one based on spatial mode jumping and the other on a spatial birth/death process. The different parameters of the several returns are estimated using reversible-jump Markov chain Monte Carlo (RJMCMC) techniques in combination with an adaptive strategy of delayed rejection to improve the estimates of the parameters. [J1524]

"Assessment of Radar Signal Attenuation Caused by the Melting Hydrometeor Layer"

Attenuation of radar signals by melting hydrometeors is studied using modeling approaches and comparisons of simulated and observed results. In spite that the melting layer in precipitating systems is usually relatively thin (~ 500 m), this attenuation can be substantial at X-band frequencies for low elevation angles and at millimeter-wavelength frequencies that are used by the U.S. Department of Energy's Atmospheric Radiation Measurement Program and CloudSat radars operating at vertical/nadir incidence. Melting layer attenuation is stronger than the attenuation in the resultant rain at comparable path lengths and needs to be accounted for in remote sensing methods that use radar reflectivity measurements for retrieving cloud and precipitation parameters if the radar beam penetrates this layer. The choice of the mixing rule for calculating dielectric constants of melting hydrometeors determines, to a significant degree, the magnitude of the modeled attenuation values. A relatively simple Wiener mixing rule provides results that are consistent with melting layer reflectivity enhancements and attenuation estimates from the X-band radar observations. The total melting layer attenuation Ais related to the resultant rain rate Rin an approximately linear manner at X- and Kalpha-band frequencies, whereas at W-band, the melting layer attenuation increase with rain rate is slower due to strong non-Rayleigh scattering effects. Typical A-Rrelations are suggested, and the variability of these relations is discussed. This paper is mostly concerned with precipitating systems associated with snowflakes that are unrimed or only slightly rimed above the freezing level, as indicated by relatively low values of vertical Doppler velocities. [J1525]

"Three-Dimensional Attributes of Clear-Air Scatterers Observed With the Polarimetric Weather Radar"

In this letter, we present a spectral technique for observation and analysis of scatterers' polarimetric attributes. This technique allows one to visualize the scatterers' spectral signatures as a function of azimuth, Doppler velocity, and polarimetric variable at the same time. Such visualization can be used to evaluate the participants of the detected motions, to understand what constitutes the polarimetric averages, and to provide resources for establishing intrinsic polarimetric values (functions) for different types of scatterers, which are necessary for the scatterers' classification algorithms. We demonstrate this technique on a clear-air case observed with the S-band polarimetric research radar in Norman, OK, on September 7, 2004. We discuss the preference for spectral density of backscatter differential phase versus other polarimetric spectral densities for the observations of clear air. The proposed visualization technique is not limited to observations of echoes in clear air and invites study of intrinsic properties for other types of scatterers. [J1526]

"Noise Radar Technology 2008 in Wroclaw"

{no data available} [J1527]

"2005 M. Barry Carlton Award [JSociety News]"

The winners of the 2005 M. Barry Carlton Award are Yanwei Wang, Xi Li, Yijun Sun, Jian Li, and Petre Stoica, for their paper, "Adaptive Imaging for Forward-Looking Ground Penetrating Radar." The paper appeared in the July 2005 issue. [J1528]

"A Stationary Wavelet-Domain Wiener Filter for Correlated Speckle"

In this paper, we develop a Wiener-type speckle filter that operates in the stationary wavelet domain. We denote it as the stationarywavelet-domainWiener(SWW) speckle filter. We assume that both the speckle-free image and the speckle contribution have spatial correlations and utilize well-established models for the power density spectrum of the radar cross section to estimate the autospectra that define the filter. It turns out that the filter is independent of the wavelet-domain scale level, i.e., the filter is the same at all scale levels. The SWW filter works on nonoverlapping blocks in the wavelet domain, which are obtained by a quadtree algorithm. Due to the dyadic support of the wavelet coefficients, a natural smoothing is carried out on the boundaries between

neighboring blocks, and no visual boundary effects can be observed. The SWW filter is unbiased and shows good performance in despeckling synthetic aperture radar (SAR) images. It smooths homogeneous areas while preserving textured areas and point scatterers. In contrast to most other speckle filters, the SWW filter requires the SAR data to be given in single-look complex form. [J1529]

"Corrections to “Calibration of Linearly Polarized Polarimetric SAR Data Subject to Faraday Rotation” [JAug 04 1617-1624]"

In the above titled paper (ibid., vol. 42, no. 8, pp. 1617-1624, Aug 04), Equation (15) has an error. Corrections are presented here. [J1530]

"Wideband radar absorbing material combining high-impedance transmission line and circuit analogue screen"

A novel design for thin and wideband absorbers is presented. The proposed absorber is a two-dimensional periodic array of unit cells, which are a combination of the high-impedance transmission line and the circuit analogue screen. The combined absorber exhibits a multiple-resonant characteristic and provides a very wide absorbing bandwidth. Measured results show that this new absorber has a bandwidth of 108% for 10 dB radar cross-section reduction with a thickness of only 7.1 and 23.7% of the free-space wavelengths at the lowest and highest operating frequencies. [J1531]

"Effect of Random Circuit Fabrication Errors on Small-Signal Gain and Phase in Traveling-Wave Tubes"

Motivated by current interest in submillimeter and terahertz (THz) slow-wave vacuum electronic amplifiers, which employ miniature, difficult-to-manufacture slow-wave circuits, we evaluate the effects of small random fabrication errors on the small-signal characteristics of a traveling wave tube. The classical 1-D small-signal theory of Pierce, generalized to allow axially varying circuit characteristics, is applied. Random, axially varying perturbations are introduced in the circuit phase velocity mismatch, the gain parameter, and the cold-tube circuit loss, in Pierce notation. Results from a first-order perturbation analysis of the small-signal equations, which are confirmed by numerical analysis, show that the standard deviations in the output phase and in the small-signal gain are linearly proportional to the standard deviations of the individual perturbations in, , and . Our study confirms that the effects of perturbations in the circuit phase velocity dominate the effects of perturbations in and . [J1532]

"Genetic SVM Approach to Semisupervised Multitemporal Classification"

The updating of classification maps, as new image acquisitions are obtained, raises the problem of ground-truth information (training samples) updating. In this context, semisupervised multitemporal classification represents an interesting though still not well consolidated approach to tackle this issue. In this letter, we propose a novel methodological solution based on this approach. Its underlying idea is to update the ground-truth information through an automatic estimation process, which exploits archived ground-truth information as well as basic indications from the user about allowed/forbidden class transitions from an acquisition date to another. This updating problem is formulated by means of the support vector machine classification approach and a constrained multiobjective optimization genetic algorithm. Experimental results on a multitemporal data set consisting of two multisensor (Landsat-5 Thematic Mapper and European Remote Sensing satellite synthetic aperture radar) images are reported and discussed. [J1533]

"Brightness Temperature Map Reconstruction from Dual-Polarimetric Visibilities in Synthetic Aperture Imaging Radiometry"

Synthetic aperture imaging radiometers are powerful sensors for high-resolution observations of the Earth at low microwave frequencies. Within this context, the European Space Agency is currently developing the soil moisture and ocean salinity (SMOS) mission devoted to the monitoring of SMOS at global scale from L-band spaceborne radiometric observations obtained with a 2-D interferometer. This paper is concerned with the reconstruction of radiometric brightness temperature maps from interferometric measurements. More exactly, it extends the concept of ldquoband-limited resolving matrixrdquo to the case of the processing of dual-polarimetric data. [J1534]

"Sea-Surface Current Features Observed by Doppler Radar"

A coherent X-band radar was operated from the shore to measure velocities at the sea surface. The test site at

a tidal inlet (Lister Tief) in the German Bight lay protected from swell and long wind waves. A vertical-vertical antenna was used to obtain the backscattered radar signal caused by Bragg scattering. To cover a sector of the circle, the antenna was rotated in 1Dstroksteps. At each step, the data acquisition was performed to obtain a time series of the backscattered radar signal. The maximum range is 1905 m with a range resolution of 7.5 m and an azimuthal resolution of 3.5diam. Maps of the averaged backscattered radar power and radial Doppler velocities are obtained. The radar backscatter maps show the modulation of the radar cross section due to changes in the surface roughness. The radar Doppler velocity maps show the modulations of the surface scatterer speed. The maps show many features, for example, the impact of subsurface sand waves, eddies, current shears, slicks, ship wakes, atmospheric effects, and small-scale current changes behind sheet pile walls. As the radar backscatter is caused by short wind waves, the wind influence on the Doppler signal was calculated for a first attempt to obtain true current motions. The results were compared with in situ current measurements. By subsequently measuring the surfaces current from two radar positions and performing the wind correction, the current vector fields are assessed. [J1535]

"Signal-to-noise ratio analysis to estimate ocean wave heights from X-band marine radar image time series"

This work analyses the structure of the different contributions to the image spectrum derived by the three-dimensional Fourier decomposition of sea clutter time series measured by ordinary X-band marine radars. The goal of this investigation is to derive a method to estimate the significant wave height of the ocean wave fields imaged by the radar. The proposed method is an extension of a technique developed for the analysis of ocean wave fields by using synthetic aperture radar systems. The basic idea behind this method is that the significant wave height is linearly dependent on the square root of the signal-to-noise ratio, where the signal is assumed as the radar analysis estimation of the wave spectral energy and the noise is computed as the energy due to the sea surface roughness, which is closely related to the speckle of the radar image. The proposed method to estimate wave heights is validated using data sets of sea clutter images measured by a marine radar and significant wave heights derived from measurements taken by a buoy used as reference sensor. [J1536]

"Adaptive radar detection in the presence of mutual coupling and near-field effects"

The problem of adaptive radar detection in the presence of near-field and mutual coupling effects-two phenomena which may significantly affect the radar performance-is considered. To this end, the generalised likelihood ratio test criterion is used (both one-step and two-step) and adaptive decision rules capable of operating in realistic scenarios are devised, where the far-field hypothesis can be no longer met and the mutual coupling is present. At the analysis stage, the performance of the proposed detectors is evaluated through Montecarlo simulations. The results show that appreciable performance improvements can be obtained if near-field and mutual coupling effects are properly accounted for at the design stage. [J1537]

"Optimisation of binary integrators for decentralised detection"

Binary integrators are an important part of the receiver in many operating radar systems. The optimisation of a binary integrator is not a simple task, because it requires the solution of a (kx n)-dimensional nonlinear optimisation problem, where nis the number of integrated bits (or the number of sensors in a distributed radar or sensor network) and kis the number of the design parameters of the single-pulse detector. An algorithm that converts the multi-dimensional optimisation problem into a one-dimensional problem, so reducing considerably the computational complexity, is developed. This reduction in computational complexity makes the real-time optimisation possible and practical, so it is very helpful for mobile sites in which the optimisation should be performed continually. The proposed algorithm can be applied when either the 'AND' or the 'OR' integration rule is adopted. The results are illustrated by means of two study cases. In the first case, the binary integrator of a constant false alarm rate radar detector is optimised; in the second one a decentralised detection system composed by nsimilar sensors is considered and the decision rules are jointly optimised according to the Neyman-Pearson criterion. [J1538]

"Change Detection in Multisensor SAR Images Using Bivariate Gamma Distributions"

This paper studies a family of distributions constructed from multivariate gamma distributions to model the statistical properties of multisensor synthetic aperture radar (SAR) images. These distributions referred to as multisensor multivariate gamma distributions (MuMGDs) are potentially interesting for detecting changes in SAR images acquired by different sensors having different numbers of looks. The first part of this paper compares different estimators for the parameters of MuMGDs. These estimators are based on the maximum likelihood principle, the method of inference function for margins, and the method of moments. The second part of the paper studies change detection algorithms based on the estimated correlation coefficient of MuMGDs. Simulation

results conducted on synthetic and real data illustrate the performance of these change detectors. [J1539]

"Recursive parametric tests for multichannel adaptive signal detection"

The problem of detecting a multichannel signal in spatially and temporally coloured disturbances is considered. The parametric Rao and parametric generalised likelihood ratio test detectors, recently developed by modelling the disturbance as a multichannel autoregressive (AR) process, have been shown to perform well with limited or even no range training data. These parametric detectors, however, assume that the model order of the multichannel AR process is known a priori to the detector. In practice, the model order has to be estimated by some model order selection technique. Meanwhile, a standard non-recursive implementation of the parametric detectors is computationally intensive since the unknown parameters have to be estimated for all possible model orders before the best one is identified. To address these issues, herein the joint model order selection, parameter estimation and target detection are considered. We present recursive versions of the aforementioned parametric detectors by integrating the multichannel Levinson algorithm, which is employed for recursive and computationally efficient parameter estimation, with a generalised Akaike Information Criterion for model order selection. Numerical results show that the proposed recursive parametric detectors, assuming no knowledge of the model order, yield a detection performance nearly identical to that of their non-recursive counterparts at significantly reduced complexity. [J1540]

"Time and phase synchronisation via direct-path signal for bistatic synthetic aperture radar systems"

Bistatic synthetic aperture radar (BiSAR) operates with distinct transmitter and receiver that are mounted on separate platforms. Such a spatial separation results in problems and special requirements that are either not encountered or encountered in less serious form for monostatic SAR. Directly associated with these requirements one has to solve the problems of highly accurate time and phase synchronisations. The impact of oscillator frequency instability on BiSAR is analysed, and a time and phase synchronisation technique via direct-path signal is proposed. With the proposed technique, the direct-path signal of transmitter is received with one appropriative antenna and divided into two channels, one is passed through an envelope detector and used to synchronise the sampling clock, and the other is down-converted and used to compensate the phase synchronisation errors. Finally, the residual time synchronisation error is compensated with range alignment, and the residual phase synchronisation error is compensated with global positioning system/inertial navigation system/inertial measurement units (GPS/INS/IMU) information; then the focusing of BiSAR image can be achieved. Based on this technique, a prototype linearly frequency modulated BiSAR synchronisation system is constructed.The effectiveness of this proposed technique is verified with simulation data. [J1541]

"Analysis and Synthesis of Raindrop Size Distribution Time Series From Disdrometer Data"

Hydrometeorological and radio propagation applications can benefit from the capability to model the time evolution of raindrop size distribution (RSD). A new stochastic vector autoregressive semi-Markov model is proposed to randomly synthesize (generate) the temporal series of the three driving parameters of a normalized gamma RSD. Rainfall intermittence is reproduced through a discrete semi-Markov process, modeled from disdrometer measurements using two-state analytical statistics of rain and dry period duration. The overall model is set up by means of a large set of disdrometer measurements, collected from 2003 to 2005 at Chilbolton, U.K. The driving parameters of the retrieved RSD are estimated using three approaches: the Gamma moment method and the 1D and 3D maximum-likelihood methods. Interestingly, these methodologies lead to quite different results, particularly when one is interested in evaluating RSD higher order moments such as the rain rate. The accuracy of the proposed RSD time-series generation technique is evaluated against available disdrometer measurements, providing excellent statistical scores. [J1542]

"Brightness Measurements and Calibration With Airborne and Terrestrial Laser Scanners"

Brightness measurement with an airborne or terrestrial laser scanner is a new concept since the intensity information recorded by the laser scanner detectors has, thus far, not been used or implemented in surface brightness studies. This is partly due to the calibration problems and the lack of information on the behavior of laser light in the observation geometry where laser scanners operate. In addition, the 3-D position information has, thus far, been sufficient for surface modeling. We present a new type of empirical calibration scheme for laser scanner intensity developed with a terrestrial laser scanner in laboratory and field conditions using brightness targets and a calibrated reference panel. We compare the results with those obtained from airborne laser scanner flight campaigns using the same set of brightness targets. It turns out that the relative calibration of laser scanner intensity is possible using a calibrated grayscale but requires background information of the targets and the conditions in which the measurements are carried out. We also discuss the feasibility and uses

of a laser-scanner-based intensity measurement in general. [J1543]

"X-Band Airborne Differential Interferometry: Results of the OrbiSAR Campaign Over the Perugia Area"

Differential synthetic aperture radar interferometry (DInSAR) is a remote sensing technique that allows monitoring ground deformation with accuracy of the order of fractions of the radiated wavelength, by means of proper combination and processing of repeat-pass data. In contrast to the satellite case, application of such a technique to airborne data is not, today, a well-established task. Several airborne campaigns, involving mainly C/L-band data, have been planned in the last years to exploit the potentialities of these more flexible platforms for deformation monitoring. In this paper, we show the results of an airborne DInSAR X-band experiment carried out over the Perugia area (center of Italy) by using the OrbiSAR system. We discuss the processing chain applied to the acquired data, which allows achieving a satisfactory compromise between accuracy and efficiency. Eleven repeated passes were carried out in two days; two corner reflectors were located on the ground in a hilly region. One corner reflector was vertically moved between the two days to evaluate the system detection capability. Moreover, we carry out an analysis of all possible differential interferograms for a region 2 4 km wide. [J1544]

"Kernel uncorrelated neighbourhood discriminative embedding for radar target recognition"

A new manifold learning algorithm, called kernel uncorrelated neighbourhood discriminative embedding (KUNDE), is presented for radar target recognition. The purpose of KUNDE is to preserve the within-class neighbouring geometry, while maximising the between-class scatter. Optimising an objective function in a kernel feature space, nonlinear features are extracted. In addition, a simple uncorrelated constraint is introduced to get statistically uncorrelated features, which is desirable for many pattern analysis applications. Experimental results on both measured and simulated data demonstrate the effectiveness of the proposed method. [J1545]

"Signal Interpretation of Multifunction Radars: Modeling and Statistical Signal Processing With Stochastic Context Free Grammar"

Multifunction radars (MFRs) are sophisticated sensors with complex dynamical modes that are widely used in surveillance and tracking. Because of their agility, a new solution to the interpretation of radar signal is critical to aircraft survivability and successful mission completion. The MFRs' three main characteristics that make their signal interpretation challenging are: i) MFRs' behavior is mission dependent, that is, selection of different radar tasks in similar tactic environment given different policies of operation; ii) MFRs' control mechanism is hierarchical and their top level commands often require symbolic representation; and iii) MFRs are event driven and difference and differential equations are often not adequate. Our approach to overcome these challenges is to employ knowledge-based statistical signal processing with syntactic domain knowledge representation: a signal-to-symbol transformer maps raw radar pulses into abstract symbols, and a symbolic inference engine interprets the syntactic structure of the symbols and estimates the state of the MFR. In particular, we model MFRs as systems that "speak" a language that can be characterized by a Markov modulated stochastic context free grammar (SCFG). We demonstrate that SCFG, modulated by a Markov chain, serves as an adequate knowledge representation of MFRs' dynamics. We then deal with the statistical signal interpretation, the threat evaluation, of the MFR signal. Two statistical estimation algorithms for MFR signal are derived-a maximum likelihood sequence estimator to estimate the system state, and a maximum likelihood parameter estimator to infer the system parameter values. Based on the interpreted radar signal, the interaction dynamics between the MFR and the target is studied and the control of the aircraft's maneuvering models is implemented. [J1546]

"Effects of Background Removal in Linear Inverse Scattering"

This paper deals with the effect of the background removal procedure on ground-penetrating radar data in the framework of a Born-based inverse-scattering solution approach for a scalar 2-D geometry. The theoretical investigation is performed by resorting to diffraction tomography reasoning, and then it is numerically confirmed thanks to the singular value decomposition of the operator that connects the unknown contrast function to the scattered field data achieved under background removal. Numerical and experimental tests are presented. [J1547]

"Two-dimensional beam-scanning microstrip leaky-wave antenna"

A novel two-dimensional beam-scanning microstrip leaky-wave antenna (MLWA) is presented. The proposed antenna consists of two half-width MLWA with a phase-shifter. This new type of MLWA has the advantages of two-dimensional beam-scanning and suppressing back lobes. This reduced size MLWA is useful in automotive

radar systems and air traffic control. [J1548]

"Signal Processing Issues for the Exploitation of Pulse-to-Pulse Encoding SAR Transponders"

Synthetic aperture radar signal processing issues related to the exploitation of a pulse-to-pulse encoding transponder using pseudorandom codes discussed analytically. Namely the focusing algorithm, the code synchronization procedure and the properties of the code induced gain against non-encoding point scatterers and distributed ones. A time-domain processing algorithm and a code synchronization procedure are proposed and validated on simulated data and on a European Remote Sensing Satellite-2 data set containing prototypes of such a device. The interaction of the transponder signal with terrain backscattering is analyzed by deriving parameters that are useful for performance assessment. These are related to the relevant parameters in radiometric calibration, interferometric applications, and tagging. [J1549]

"Methods for Locating Stray-Signal Sources in Anechoic Chambers"

Two complementary numerically efficient frequency-domain methods for locating stray-signal sources in anechoic chambers are investigated and applied in combination to actual measurement data. Both methods use single-frequency near-field data collected on a planar surface and process them to reconstruct field values (images) elsewhere. The first method, which is based on the fact that the probe output satisfies the Helmholtz equation, uses plane waves to backpropagate the scan-plane data and is well suited for fast-Fourier-transform (FFT)-based rapid reconstruction of images on planar surfaces parallel to the scan plane. The second method uses the simple spherical-wave focusing technique and is flexible, in that, it can be used to generate images on either planar or nonplanar surfaces from the data collected on either planar or nonplanar surfaces. When data and image points are both located on a regular grid, the method can be implemented using the FFT-based fast convolution technique. Both methods include a spatial filter for isolating selected plane-wave spectrum components. The two methods are used in combination to successfully locate the strong multiple-bounce stray signals that degrade the quiet zone of a near-field bistatic radar cross-section facility. Subsequent scan data confirm that the suppression of these stray signals indeed substantially improves the quality of the quiet zone. The spherical-focusing method is also used to evaluate the effectiveness of the various absorber configurations applied to selected edges of the reflector to control edge-diffracted fields. It is shown that the reduction of the edge-diffracted fields further improves the quiet zone. [J1550]

"On the Disaggregation of Passive Microwave Soil Moisture Data Using A Priori Knowledge of Temporally Persistent Soil Moisture Fields"

Water and energy fluxes at the interface between the land surface and atmosphere are affected by the surface water content of the soil, which is highly variable in space and time. The sensitivity of active and passive microwave remote sensing data to surface soil moisture content has been investigated in numerous studies. Recent satellite mission concepts as, for example, the soil moisture and ocean salinity (SMOS) mission, are dedicated to provide global soil moisture information with a temporal frequency of a few days to capture the high temporal dynamics of surface soil moisture. SMOS soil moisture products are expected to have geometric resolutions on the order of 40 km. Mesoscale flood forecasting or water balance models typically operate at much higher spatial resolutions on the order of 1 km. It seems therefore essential to develop appropriate disaggregation schemes to benefit from the high temporal frequency of the SMOS data for hydrological applications as well as, for example, local numerical weather prediction models that are operated at a resolution of a few kilometers. This paper investigates the potential of using prior information on spatially persistent soil moisture fields to disaggregate SMOS scale soil moisture products. The approach is based on a ten-year soil moisture climatology for a mesoscale hydrological catchment, situated in southern Germany, which was generated using a state-of-the-art land-surface process model. The performance of the disaggregation algorithm is verified by comparison of disaggregated soil moisture fields with another ten-year period. To investigate the potential of the suggested disaggregation method for SMOS soil moisture products, a ten-year synthetic brightness temperature data set is generated at the 1-km scale. soil moisture is then retrieved from the aggregated brightness temperature data at the SMOS type scale of 40 km and then disaggregated using the suggested approach. The results are compared against reference--soil moisture at the 1-km scale. Uncertainties in the retrieval of the SMOS soil moisture products are explicitly considered, and the uncertainties of the disaggregated fields are quantified. The developed method shows a generally good performance for large parts of the test site, where soil moisture can be disaggregated with an accuracy that is better than the 4 vol.% benchmark of the SMOS mission. As the suggested method shows high sensitivity to biased soil moisture retrievals, uncertainties of the SMOS soil moisture products will directly reflect on the absolute accuracy of the disaggregated soil moisture fields, resulting in a much worse performance under noisy conditions. Nevertheless, the resulting soil moisture distributions show that it is feasible to derive relative soil moisture distributions in these cases. [J1551]

"Matching-Pursuit-Based Analysis of Moving Objects in Polarimetric SAR Images"

This letter deals with the analysis of moving and nonstationary objects in already focused synthetic aperture radar (SAR) images. A method based on the matching pursuit (MP) algorithm is proposed to decompose the SAR signal into a set of atoms. A model of a moving object response with frequency- and angle-dependent reflectivity is introduced to design the MP atoms. Each selected atom is associated to a scatterer of the scene and is parameterized by relevant physical descriptors, leading to a multidimensional model of the object. The efficiency of this technique is demonstrated in terms of SAR response refocusing and physical parameter map derivation, using a polarimetric SAR image of a moving object lying in a natural background. [J1552]

"IEEE Dennis J. Picard Medal for Radar Technologies & Applications"

{no data available} [J1553]

"International Radar Symposium IRS 2007 in Cologne, Germany [JConference Report]"

{no data available} [J1554]

"Analysis of the LAD Methods"

A localization algorithm based on double-thresholding (LAD) has been recently proposed for localizing concentrated signal(s) in the frequency or time domain. The LAD method blindly detects and separates concentrated signals and estimates their characteristics. This letter presents a theoretical performance analysis of the LAD method and an enhancement of the LAD method: the LAD with adjacent cluster combining (ACC). The good detection performance of the LAD ACC method is confirmed both theoretically and numerically. [J1555]

"Sigrid Close-Star Struck [Jdream jobs 2008]"

First Page of the Article [J1556]

"High-Resolution SAR Interferometry: Estimation of Local Frequencies in the Context of Alpine Glaciers"

Synthetic aperture radar (SAR) interferometric data offer the opportunity to measure temperate glacier surface topography and displacement. The increase of the resolution provided by the most recent SAR systems has some critical implications. For instance, a reliable estimate of the phase gradient can only be achieved by using interferogram local frequencies. In this paper, an original two-step method for estimating local frequencies is proposed. The 2-D phase signal is considered to have two deterministic components corresponding to low-resolution (LR) fringes and high-resolution (HR) patterns due to the local microrelief, respectively. The first step of the proposed algorithm consists in the LR phase flattening. In the second step, the local HR frequencies are estimated from the phase 2-D autocorrelation function computed on adaptive neighborhoods. This neighborhood is the set of connected pixels belonging to the same HR spatial feature and respecting the ldquolocal stationarityrdquo hypothesis. Results with both simulated TerraSAR-X interferograms and real airborne E-SAR images are presented to illustrate the potential of the proposed method. [J1557]

"Signal Processing in Noise Radar Technology [JEditorial]"

Noise radar technology (NRT) addresses the increasing performance demands placed on both military and civilian radar systems by enhancing their reliable operation in congested, unfriendly or hostile environments. For instance, many surface and maritime radar systems used for national border surveillance, traffic control, indoor surveillance, etc. must be able to operate in a congested electromagnetic environment without performance degradations caused by intentional external electromagnetic interference (EMI). Even greater demands are placed on military air, space, maritime and battlefield radar systems that must reliably operate in congested and hostile environments characterized by deliberate and adaptive jamming. In addition, many military missions require covert radar operation, which increases the complexity of radar signal processing. [J1558]

"Range-velocity estimation of multiple targets in randomised stepped-frequency radar"

A novel algorithm for estimating the ranges and velocities of multiple moving targets in randomised stepped-frequency pulse-train radar is presented. By using the iterative alternating projection technique, this algorithm can achieve high range-velocity resolution and estimation accuracy close to the Cramer-Rao bounds. The sidelobe pedestal problem of randomised stepped-frequency waveforms can also be mitigated. The effectiveness of the algorithm is illustrated with simulation results. [J1559]

"Ka-band bistatic ground-based noise waveform SAR for short-range applications"

The designing and testing of a new Ka-band ground-based noise waveform synthetic aperture radar (GB NW-SAR) are presented. Its design is based upon new synthetic aperture antennas and noise radar technology. The authors present preliminary results of its indoor trials. The GB NW-SAR designed may be reconfigured for operation in mono-, bi- and multistatic (or MIMO) modes in both CW and pulse regimes using single- and dual-frequency modes to enhance range resolution via expanding the frequency bandwidth of the signal. Potential resolution of the GB NW-SAR is 15 cm both in range and azimuth. Results of indoor trials are presented for both SAR imaging and differential interferometry measurements. Designed and tested Ka-band GB NW-SAR is applicable for precise remote monitoring of various manmade or natural objects, such as ceilings and roofs of big halls and hangars, dams, bridges, TV towers etc. [J1560]

"Adaptive chaotic maps for identification of complex targets"

Identification of complex targets in radar or sonar is a difficult problem. The author shows how the parameters of a simple chaotic map may be optimised to increase the cross correlation of a transmitted signal with the reflection from one target while decreasing the cross correlation with another target. The targets consist of simple arrays of point scatterers. The author shows that the optimisation process produces a chaotic signal with a power spectrum that maximises the ratio of the cross correlation with one target to the cross correlation with a different target, however the author also shows that the specific time ordering of the chaotic signal is also important in determining the cross correlation. The performance of the chaotic signal is better than a random signal with the same power spectrum. The author also shows an example of applying these methods to targets that are more complex. [J1561]

"Hilbert-Huang transform analysis of human activities using through-wall noise and noise-like radar"

Various parts of the human body have different movements when a person is performing different physical activities. There is a need to remotely detect and recognise specific human activities for applications involving anti-terrorism, hostage liberation and search-and-rescue. An ultrawideband noise radar system has been built to detect signatures of human activities. The Hilbert-Huang transform, which is used to extract the human-induced Doppler frequency shift from the received signal, facilitates the identification and recognition of various human activities. A non-stationary Doppler model is developed to describe various aspects of human motion, which compares well with measured data. The theoretical analysis and experimental results are discussed. [J1562]

"Perfect polyphase sequences with small alphabet"

New perfect polyphase sequences with a small phase alphabet and some zero elements are proposed. These sequences are derived from pairs of perfect polyphase sequences with zeroes and odd-perfect ternary sequences of the same length N. They have a length of 4Nand possess a peak factor close to 1 as Nbecomes large. The sequences can be used in digital communication, navigation and radar engineering. [J1563]

"MIMO Radar Ambiguity Properties and Optimization Using Frequency-Hopping Waveforms"

The concept of multiple-input multiple-output (MIMO) radars has drawn considerable attention recently. Unlike the traditional single-input multiple-output (SIMO) radar which emits coherent waveforms to form a focused beam, the MIMO radar can transmit orthogonal (or incoherent) waveforms. These waveforms can be used to increase the system spatial resolution. The waveforms also affect the range and Doppler resolution. In traditional (SIMO) radars, the ambiguity function of the transmitted pulse characterizes the compromise between range and Doppler resolutions. It is a major tool for studying and analyzing radar signals. Recently, the idea of ambiguity function has been extended to the case of MIMO radar. In this paper, some mathematical properties of the MIMO radar ambiguity function are first derived. These properties provide some insights into the MIMO radar waveform design. Then a new algorithm for designing the orthogonal frequency-hopping waveforms is proposed. This algorithm reduces the sidelobes in the corresponding MIMO radar ambiguity function and makes the energy of the ambiguity function spread evenly in the range and angular dimensions. [J1564]

"A Physical-Optics Model for Double-Bounce Scattering From Tree Stems Standing on an Undulating Ground Surface"

In this paper, a model for prediction of radar backscatter from coniferous forests in the VHF and UHF band is proposed. The model includes the double-bounce scattering originating from vertical stems standing on an undulating ground surface and is based on a physical-optics approach. The model can be used to assess the importance of ground topography in synthetic aperture radar (SAR) imagery of forests, and it is applicable to

SAR systems using horizontally transmit and receive polarization (HH). The model was validated against data from the airborne SAR systems CARABAS-II and LORA. Precision measurements of ground topography and forest characterization at a single tree level were used as model input to simulate SAR images. The simulated images were compared to radar data in the frequency bands 22-82 and 225- 470 MHz, and it was found that the model could predict much of the variation in backscatter observed in images (R2= 0.44 and 0.65 at best, for the lower and higher frequency band, respectively), which should be compared to R2= 0.1 if the same model, but assuming a flat ground, was used. The results thus indicate that ground topography must be considered when predicting the variations in backscatter in the SAR images studied. The model did, however, fail to predict the absolute values of the backscattered intensity. The reason for the discrepancy is believed to be the value chosen for stem dielectric constant and unmodeled effects due to wave attenuation, tilting stems, and small-scale surface roughness. [J1565]

"Efficient Design of High-Complexity Cosine Modulated Filter Banks Using th Band Conditions"

This paper presents several new properties of biorthogonal cosine modulated filter banks (CMFBs) and efficient algorithms for designing CMFBs with a very large number of subbands and very long filters. For a biorthogonal CMFB, we find the periodicity and symmetry of its overall transfer function and aliasing transfer functions which can be efficiently computed based on a decimated uniform discrete Fourier transform (DFT) analysis filter bank. By exploiting gradient information and 2Mth band conditions, efficient algorithms are proposed for designing both orthogonal and biorthogonal CMFBs. In addition, an efficient matrix inversion algorithm with O(N2) complexity is also presented. Several numerical examples and comparisons with many other existing methods are included to demonstrate the design performance and efficiency of the algorithms. [J1566]

"Small-size printed CPW-fed antenna for ultra-wideband communications"

A novel printed monopole antenna fed by a coplanar waveguide (CPW) is proposed in view of ultra-wideband applications. Its impedance bandwidth defined by a voltage standing-wave ratio (VSWR < 2) is from 3 to 11.3 GHz with a fractional bandwidth of 116%. A parametric study of the proposed antenna was carried out in order to optimise the main parameters. Details of the proposed antenna design and measured results are presented and discussed. [J1567]

"From Glacier Facies to SAR Backscatter Zones via GPR"

We present a comparison between data acquired with frequency-modulated ground-penetrating radar (GPR) and satellite synthetic aperture radar (SAR). Both radars are polarimetric and operate at a center frequency of 5.3 GHz. The field site is the polythermal glacier Kongsvegen, Svalbard. Along glacier GPR profiles cover the ablation area and the accumulation area, where the latter consists of superimposed ice (SI) and firn. The glacier facies are clearly identifiable on the GPR profiles, although we show that the copolarized response is better for distinguishing different ice zones, whereas the SI-firn boundary is most obvious in the cross-polarized response. A calibrated backscatter coefficient is calculated for the GPR data and compared with the SAR backscatter coefficient. The SAR zones are in very good agreement with the GPR-derived glacier facies. We show that, in the ablation area, the SAR response is dominated by backscatter from the previous summer surface. In the SI and firn areas, it is dominated by sources below the previous summer surface. [J1568]

"Quality enhancement of image generated with bistatic ground based noise waveform SAR"

A new method for quality enhancement in a noise synthetic aperture radar (SAR) image and the first results of its application to the SAR image generated with the use of a bistatic Ka-band ground-based noise waveform SAR (GB NW-SAR) are presented. A SAR image generated with a noise SAR suffers from the masking effect which is tied to residual random fluctuations in noise radar response from bright scatterers in the scene. This is similar to the masking effect present in the deterministic waveform SAR when the signal sidelobes of echoes from bright scatterers may mask the main response from a weaker target. The procedure presented is a variation of the CLEAN algorithm. Knowing precisely the emitted signal and finding positions of the strongest scatterers one may model the echo signal originated from a selected scatterer. Extraction of the modelled signal from the received one reduces the residual fluctuations and makes it possible to clean the image and increase its dynamic range. The final image is constructed from the cleaned signal and the previously removed strongest scatterers. A theoretical background is provided to the proposed procedure and its application to enhance the SAR image using simulated data as well as data generated by the Ka-band bistatic GB NW-SAR is demonstrated. The GB NW-SAR, recently developed and tested in LNDES IRE NASU, may operate in CW and pulse random signal regimes for short range applications. [J1569]

"Bispectral analysis of atmospheric radar signals"

The bispectral analysis techniques have been applied on signals received from the back-scattered signals by the MST radar. The results of this analysis are compared with that of the conventional power spectral analysis using the fast Fourier transform (FFT) technique. Our results showed that there is a significant advantage in using the bispectral technique over the conventional FFT technique. This study focuses on the importance of bispectral analysis in applications to atmospheric signals. [J1570]

"Fiber lasers: A future space technology [Jsame article as "Fiber lasers: A future technology for lasers in space", ibid, vol. 23, n. 4, pp. 25-30, 08]"

The constraints of operation in space have largely precluded the use of conventional solid-state laser systems for applications including remote sensing, communication relays, and active laser radars. A new technology, fiber lasers, may offer all of the needed features at an affordable price. An appealing aspect of the fiber laser is that it does not need a rigid optical bench. Only the output end of the fiber need be held in rigid reference to the optical tracking system. Design, fabrication, and testing of the laser resonator is generally the most expensive and longest lead part of the effort for conventional solid-state lasers. Advances in Fiber Optic technology and devices mean that the "fiber laser" need not be a simple device but may be a complex system employing sophisticated technology such as wavelength selective Bragg reflectors and nonlinear optical frequency shifters. Three companies have recently obtained single-mode outputs of 3540 watts single mode at 1.03-1.1 microns. [J1571]

"Sequential Detection of Markov Targets With Trajectory Estimation"

The problem of detection and possible estimation of a signal generated by a dynamic system when a variable number of noisy measurements can be taken is here considered. Assuming a Markov evolution of the system (in particular, the pair signal-observation forms a hidden Markov model (HMM)), a sequential procedure is proposed, wherein the detection part is a sequential probability ratio test (SPRT) and the estimation part relies upon a maximum aposterioriprobability (MAP) criterion, gated by the detection stage (the parameter to be estimated is the trajectory of the state evolution of the system itself). A thorough analysis of the asymptotic behavior of the test in this new scenario is given, and sufficient conditions for its asymptotic optimality are stated, i.e., for almost sure minimization of the stopping time and for (first-order) minimization of any moment of its distribution. An application to radar surveillance problems is also examined. [J1572]

"Doppler Resilient Golay Complementary Waveforms"

We describe a method of constructing a sequence (pulse train) of phase-coded waveforms, for which the ambiguity function is free of range sidelobes along modest Doppler shifts. The constituent waveforms are Golay complementary waveforms which have ideal ambiguity along the zero Doppler axis but are sensitive to nonzero Doppler shifts. We extend this construction to multiple dimensions, in particular to radar polarimetry, where the two dimensions are realized by orthogonal polarizations. Here we determine a sequence of two-by-two Alamouti matrices where the entries involve Golay pairs and for which the range sidelobes associated with a matrix-valued ambiguity function vanish at modest Doppler shifts. The Prouhet-Thue-Morse sequence plays a key role in the construction of Doppler resilient sequences of Golay complementary waveforms. [J1573]

"The Finite Harmonic Oscillator and Its Applications to Sequences, Communication, and Radar"

A novel system, called the oscillator system, consisting of order of p3functions (signals) on the finite field Fp, with p an odd prime, is described and studied. The new functions are proved to satisfy good autocorrelation, cross-correlation, and low peak-to- average power ratio properties. Moreover, the oscillator system is closed under the operation of discrete Fourier transform. Applications of the oscillator system for discrete radar and digital communication theory are explained. Finally, an explicit algorithm to construct the oscillator system is presented. [J1574]

"Compression of multi-polarimetric SAR intensity images based on 3D-matrix transform"

The algorithms for multi-polarimetric synthetic aperture radar (SAR) intensity image compression are investigated. First, the multi-polarimetric SAR intensity images (HH, HV and VV) are considered as a 3D-matrix unit, and then a 3D-matrix transform is adopted to remove the redundancies, which includes ID discrete cosine transform (DCT) in the polarimetric channels and 2D discrete wavelet transform (DWT) in each polarimetric SAR image plane. After the 3D-matrix transform, two methods are proposed to encode the 3D mixed coefficients. One is a bit allocation encoding based on differential entropy and the other is a 3D set partitioning in hierarchical trees (SPIHT) encoding which is an improvement of the conventional SPIHT. The two methods can remove not only the redundancies of the image inside but also the redundancies among the polarimetric channels, because they do not process every channel image separately. Both the theory and experimental results show that the

proposed methods are efficient. [J1575]

"Robustification of noise radar detection"

A study of robust detection scheme for continuous wave noise radars is presented. The probability density function (PDF) of the noise at the input of the radar is not usually Gaussian and has heavy tails generated by impulse interferences. Although the PDF of interferences at the output of the noise radar correlator is Gaussian, impulse interferences increase the processing floor, and thus decrease the overall radar sensitivity. The proposed robustification applied to the correlator's input signal increases the radar sensitivity in the presence of impulse interferences, and does not introduce any significant losses if the input noise is purely Gaussian. [J1576]

"Stretch processing for masking effect removal in noise radar"

A method of removing the masking effect caused by strong target echoes in a noise radar is presented. Signal processing in noise radar is based on the calculation of the correlation between transmitted and received signals. Strong echoes of nearby targets produce relatively high sidelobes in the correlation function, thus masking weak echoes of far targets. The classical method of masking effect removal, taking into consideration only the Doppler shift of target echoes, does not remove the strong target echo completely when targets migrate between range resolution cells in the integration time. The method proposed, based on signal stretch processing and a point target model, shows an improvement over existing methods and allows for the detection of weak targets also in the presence of the fast and strong ones. [J1577]

"Mutual interference and low probability of interception capabilities of noise radar"

Recently, there has been considerable interest in noise radar over a wide spectrum of applications, such as through-wall surveillance, tracking, Doppler estimation, polarimetry, interferometry, ground penetrating or subsurface profiling, detection, synthetic aperture radar (SAR) imaging, inverse SAR imaging, foliage penetration imaging etc. Major advantages of using noise in the transmit signal are its inherent immunity from radio frequency and electromagnetic interference, improved spectrum efficiency, and hostile jamming as well as being very difficult to detect. The basic theory of digital signal processing in noise radar design is treated. The theory supports the use of noise waveforms for radar detection and imaging in such applications as covert military surveillance and reconnaissance. It is shown that by using wideband noise waveforms, one can achieve high resolution and reduced range estimation ambiguity. Mutual interference and low probability of interception capabilities of noise radar are also evaluated. The simulation results show the usefulness of the noise radar technology to improve on conventional radars. [J1578]

"Ultra-wideband radar noise reduction for target classification"

The authors describe a calibration procedure for ultra-wideband (UWB) radar systems in order to measure the frequency-dependent transfer function or radar cross-section, respectively, of objects with a high computational efficiency. The benefit of using UWB pulses is that only one measurement is required for covering several GHz. However, the signal processing steps contain a deconvolution operation producing spike artefacts. They were successfully removed by the calculation of frequency-dependent signal-to-noise ratio and a following Wiener filtering. The proposed method was verified by some elementary targets of which the size of the objects were determined. [J1579]

"Time-frequency-based non-stationary interference suppression for noise radar systems"

The problem addressed here is non-stationary interference suppression in noise radar systems. Towards this aim, two linear time-frequency (TF) transforms, short-time Fourier transform and local polynomial Fourier transform are used as a means of signal representation and filtering. The noise radar return signal is a wideband random signal occupying the whole TF plane, whereas the interference signal is well concentrated in the TF plane. This implies that the filtering of the received signal can be performed by using a binary mask to excise only a portion of the TF plane corrupted by the interference. Simulations carried out on the radar return signal corrupted by extremely strong non-stationary interferences confirm the effectiveness of the proposed method. [J1580]

"A Refined GTD Ray System for an Embedded Object and Its Polarimetric Behavior"

A refined ray system based on the geometrical theory of diffraction (GTD) for an object embedded in soil for a monostatic transmitter-receiver alignment is presented. Apart from the investigation of the ldquoclassicalrdquo reflections from the target, creeping waves are also taken into account, and their formalism is presented. The objective of such a ray set is to better understand the different scattering mechanisms, which are presented in

the complex scattering framework. In electromagnetic modeling based on GTD, the complex shape of a target is replaced by simpler canonical objects, e.g., facets, cones, wedges, spheres, or cylinders. Here, a cylinder is located in parallel and closely to the plane interface of two dielectric half-spaces. The example of air-soil is taken into account. The numerical results obtained for various directions of incidence are employed to describe the polarimetric characteristics of the diffracted field from grazing to perpendicular incidence to the surface. By representing the diffracted GTD field on the Poincare sphere, the location on the sphere has a one-to-one relationship to the dielectric properties of the soil. The relation can be employed to extract information as the soil moisture. [J1581]

"Side-Face Effect of a Dielectric Strip on Its Optical Properties"

Light scattering by horizontally oriented platelike particles under normal incidence, such as ice plates or tree leaves under spaceborne lidar or radar waves, needs to be investigated for remote sensing of cirrus clouds or vegetation canopies. The solutions from the conventional geometrical ray tracing method for the scattering of electromagnetic waves by these particles are quite inaccurate because of the singularity problem that is inherent to this method. The scattering properties of large horizontally oriented platelike particles are usually approximated by using physical optics or electromagnetic wave theory while ignoring the side-face effect of the plates. In this paper, to examine the effect of side faces on light scattering by platelike particles, a 2-D finite-difference time-domain technique is applied to calculate light scattering by horizontally oriented ice and leaf strips under normal or quasi-normal incidence. It is found that for moderate-sized strips, the side faces of the particles scatter a significant amount of energy, resulting in strong maxima in the scattering phase function at certain scattering angles. By ignoring the effect of side faces, the scattering phase functions derived from electromagnetic wave theory have significant errors for small or moderate-sized strips. However, the ratio of the amount of energy scattered by the side faces to the total scattered energy decreases with the increase of strip width. When the size parameter of the strip is in the limit of geometric optics, the side-face effect is reduced to a negligible amount. However, even in this case, the polarization degrees from the approximation solutions of physical optics or electromagnetic wave theory ignoring the side-face effect still have large errors. [J1582]

"Focusing Bistatic SAR Data Using the Nonlinear Chirp Scaling Algorithm"

Bistatic synthetic aperture radar data are more challenging to process than the common monostatic counterparts because the flight geometry is more complicated and the data are usually nonstationary. Whereas time-domain algorithms can handle general bistatic cases, they are very inefficient; therefore, frequency-domain methods are preferred. Several frequency-domain monostatic algorithms have been modified to handle a limited number of bistatic cases, but a general algorithm is sought, which can handle cases such as nonequal platform velocities, nonparallel flight tracks, and high squints. In this paper, we modify the nonlinear chirp scaling (NLCS) algorithm to handle a general case of bistatic data. The key is to use a linear range cell migration correction to reduce the range-azimuth coupling, an NLCS to precondition the data for azimuth compression, and a series expansion to obtain an accurate form of the signal spectrum. The azimuth nonstationarity is handled through the use of invariance regions. Simulations have shown that the modified NLCS algorithm can handle data with more complicated bistatic geometries than the previous algorithms. [J1583]

"Novel radar target detection [Jsame as "Radar target novel characteristic detection method", vol. 21, n.1, 06]"

Herein, a novel method of radar target detection based on 2-dimensional (2-D) fractal dimension is proposed. The proposed approach exploits both range information and azimuth information to estimate fractal dimension. Moreover, the approach can increase the number of data points. The above two merits result in the fractal dimension estimated by this method are more accurate and robust than the previous method. The detection performance is also better than the previous, which only makes use of 1-dimensional (1-D) information to estimate fractal dimension. Theoretical analysis and experimental results show that the proposed method performs well in a strong clutter background. The proposed method is also validated by real-life radar data, and the better result has been achieved. [J1584]

"Sikkim's Teesta River fog, mist and dust particle monitoring using monostatic LiDAR"

Fog, mist, and atmospheric dust particles, having the dimension of one micrometer or less, play an important role in the deterioration of visibility, as well as in causing local warming in the atmosphere. With an attempt to reduce the deterioration, a scientific approach has to be taken to determine their origins. A monostatic LIDAR may be one of the best instruments for such work. The authors are tempted to develop such a LIDAR for fog, mist, and dust particle monitoring over River Teesta at Sikkim. LIDAR is an acronym for Light Detection And Ranging. What can we do with LIDAR? Measure distance, measure speed, measure rotation, measure chemical

composition and concentration, and measure cross-sections of the targets. The digital technique is always utilized for its development which results in better security, lower power consumption, higher power efficiency, higher reliability, lower transmitter power, lower multipath effect, higher interference suppression as compared to an analog system. The commercial systems like disdometer, rain radar, mobile robot, etc., utilizing LIDAR principles are operational in different parts of the world. The authors are highly motivated for such LIDAR development and their development effort follows. [J1585]

"Radarsat-1 and ERS InSAR Analysis Over Southeastern Coastal Louisiana: Implications for Mapping Water-Level Changes Beneath Swamp Forests"

Detailed analysis of C-band European Remote Sensing 1 and 2 (ERS-1/ERS-2) and Radarsat-1 interferometric synthetic aperture radar (InSAR) imagery was conducted to study water-level changes of coastal wetlands of southeastern Louisiana. Radar backscattering and InSAR coherence suggest that the dominant radar backscattering mechanism for swamp forest and saline marsh is double-bounce backscattering, implying that InSAR images can be used to estimate water-level changes with unprecedented spatial details. On the one hand, InSAR images suggest that water-level changes over the study site can be dynamic and spatially heterogeneous and cannot be represented by readings from sparsely distributed gauge stations. On the other hand, InSAR phase measurements are disconnected by structures and other barriers and require absolute water-level measurements from gauge stations or other sources to convert InSAR phase values to absolute water-level changes. [J1586]

"Whitening Dual-Polarized Weather Radar Signals With a Hermitian Transformation"

Oversampling weather radar signals in range and then whitening these signals has been shown to improve the accuracy of spectral moments. For dual-polarized radar, the polarimetric variables depend upon information gleaned from the cross correlation of the different received signals. Theoretical improvements to the polarimetric variables have been provided to date, but experimental evidence of improvements through whitening has been limited. This paper provides an analysis of the effects of whitening on the estimated cross correlation along with experimental results of whitening applied to polarimetric variables. Different whitening transformations based solely on covariance matrix inversions will be shown to affect the copolar correlation of the whitened data. A Hermitian symmetric whitening transformation will be shown to produce better estimates of polarimetric variables obtained from whitened data than the original whitening transformation defined for use with range oversampling. [J1587]

"The Detection of Buried Pipes From Time-of-Flight Radar Data"

Ultrawideband radar is commonly used in the frequency range of 50-500 MHz to detect buried pipes at a depth of about 1-2 m depending on the soil characteristics. The typical feature used to locate the pipes is the hyperbolic pattern of the time of flight generated by a linear scan of the antenna above the surface. When the pipes are close together, the hyperbolas overlap, and a straightforward least squares fit is not possible. The Hough transform provides one possible solution. This paper extends the Hough transform by introducing a weighting factor depending on the differentials of the unknown parameters with respect to the experimental errors, namely, the probe position error and the time-of-flight error. This enables optimally placed sets of data pairs to be given greater weight than "ill-conditioned" sets, as for example when all data pairs lie near one end of the arc. The result is a decrease in the background amplitude with respect to the maximum of the peaks in the Hough accumulator space. It is shown that this improvement persists even when many arcs are present. A mathematical analysis with analytical results is given for the case of four unknowns: pipe radius R, pipe center position (Y, Z), and soil propagation velocity V. The results are presented through simulations introducing controlled uncertainties in the probe position, the time of flight, and its bin size. The simulations demonstrate the correlations that occur between the radius, depth, and velocity for given experimental uncertainties. [J1588]

"Imaging Simulation of Bistatic Synthetic Aperture Radar and Its Polarimetric Analysis"

Employing the 3-D mapping and projection algorithm (MPA), an imaging simulation of bistatic synthetic aperture radar (BISAR) observation over a complex scenario is developed. Based on the explicit expression of the point target response of stripmap BISAR imaging, raw data are efficiently generated from the scattering map precalculated by MPA. Some examples of BISAR image simulation are studied. The polarimetric characteristics of a BISAR image are then discussed. It is found that some typical polarimetric parameters such as Cloude's alpha, beta and gamma and might become unable to describe the scattering mechanism under bistatic observation. A transform of unified bistatic polar bases for a BISAR image is proposed. The parameters alpha, beta and gamma and are modified to retain the property of orientation independence in the bistatic circumstance. Analysis of simulated images shows that the redefined alpha, beta and gamma and after the unified bistatic polar

bases transform well describe different scattering mechanisms in BISAR imaging. It provides a primary tool for BISAR image interpretation and terrain classification. [J1589]

"A Multistatic GNSS Synthetic Aperture Radar for Surface Characterization"

Bistatic global navigation satellite system (GNSS) radar has received increased attention in recent years within both the radar and GNSS communities. In this paper, the traditional bistatic GNSS radar and bistatic synthetic aperture radar (SAR) concepts are fused into a more generic multistatic GNSS SAR system for surface characterization. This is done by using the range and Doppler processing techniques on signals transmitted by multiple satellites to determine the angular dependence of the surface reflectivity. The method has also been tested experimentally, and the results are presented. [J1590]

"Soil Moisture Retrieval During a Corn Growth Cycle Using L-Band (1.6 GHz) Radar Observations"

This paper reports on the retrieval of soil moisture from dual-polarized L-band (1.6 GHz) radar observations acquired at view angles of 15deg, 35deg, and 55deg, which were collected during a field campaign covering a corn growth cycle in 2002. The applied soil moisture retrieval algorithm includes a surface roughness and vegetation correction and could potentially be implemented as an operational global soil moisture retrieval algorithm. The surface roughness parameterization is obtained through inversion of the Integral Equation Method (IEM) from dual-polarized (HH and VV) radar observations acquired under nearly bare soil conditions. The vegetation correction is based on the relationship found between the ratio of modeled bare soil scattering contribution and observed backscatter coefficient (sigmasoil/sigmaobs) and vegetation water content (W). Validation of the retrieval algorithm against ground measurements shows that the top 5-cm soil moisture can be estimated with an accuracy between 0.033 and 0.064 cm3ldr cm-3, depending on the view angle and polarization. [J1591]

"Advances in bistatic radar (Willis, N.J. and Griffiths, H.D., Eds.; 2007) [JBook Review]"

The editors have collected a comprehensive set of monographs that provide insight into the more recent history of bistatic radar design and implementation. This volume combines improved details of the environment along with novel system applications. Each chapter is authored by radar experts who had the vision and motivation to tackle a daunting development problem, and share their view of the successes and remaining implementation challenges. The book is divided into two parts: Bistatic/Multistatic Systems and Bistatic Clutter and Signal Processing. The book is an essential addition to the modern radar engineer's library. [J1592]

"Scaled Measurements of Instrument-Landing-System Disturbances Due to Large Taxiing Aircraft"

It is commonly known that the directional pattern of the instrument landing system (ILS)-localizer antenna system, which constitutes the landing-course information for approaching aircraft, can be disturbed by reflections from large aircraft on the ground. Therefore, airport operators are interested in knowing configurations of landed and taxiing aircraft that lead to such ILS disturbance scenarios. Measurements on a real airport for investigating such scenarios are very cost-intensive and not sufficiently possible due to availability reasons. Therefore, a new scaled measurement setup is presented. Scaling down an aircraft by the factor of 144 requires a scaled ILS-localizer operating at a frequency of nearly 16 GHz, the development and realization of which is presented in this paper. Using this scaled ILS-localizer, measurements with an Airbus A380 and a Boeing B747 are conducted showing the feasibility of the scaled approach. Several configurations are shown where those aircraft lead to interferences of the ILS, exceeding allowed tolerances. A comparison of the reflection behavior of both aircraft shows only slight differences. Additionally, this paper presents the derivation of the bistatic radar cross section of both aircraft to be applicable to scenarios with arbitrary ILS patterns. [J1593]

"EMC Impact of Advanced Carbon Fiber/Carbon Nanotube Reinforced Composites for Next-Generation Aerospace Applications"

This paper presents a comparative analysis of the electromagnetic properties of new composite materials that are of interest to future aircraft/aerospace structures. The fabrication process of single-phase and new multiphase micro/nanocomposites is described. Carbon black, carbon fibers, and multiwall carbon nanotubes are randomly mixed into an epoxy resin matrix at various weight fractions and compositions. The experimental characterization in the frequency range 8-18 GHz shows that the dispersion characteristics of short-carbon-fiber-reinforced composites can be properly controlled by the addition of nanopowders and nanotubes into the mixture. Numerical simulations demonstrate the feasibility of the fabricated materials for the design of new electromagnetic micro/nanostructured shields and radar-absorbing laminates. Thin dielectric Salisbury screens are especially designed to exhibit minimum reflection coefficient at 15 GHz. It shows that the total thickness of the screen can be reduced below 2 mm by using a lossy sheet made of three-phase composites. [J1594]

"Refractivity Retrieval Using the Phased-Array Radar: First Results and Potential for Multimission Operation"

In this paper, an investigation of the potential of rapid refractivity retrieval is presented. The retrieval technique utilizes radar phase measurements of ground clutter to derive near-surface refractivity, which has been commonly used as a proxy for humidity, given its close relation to vapor pressure. Surface humidity is an important meteorological parameter and has been known to play an important role in convective initiation. In this paper, the refractivity retrieval technique is exploited by using smaller numbers of samples for phase calculation, which is a fundamental process in refractivity retrieval. The impetus for this paper is to explore the possibility of rapid refractivity retrieval by exploiting the rapid beam-steering capability of a phased-array radar. Using the National Weather Radar Testbed in Norman, OK, a 64-pulse per radial raw-data set was collected for conventional refractivity processing. Then, subsets of the 64 samples were extracted to emulate shorter dwell periods and the corresponding more rapid experiments. The test cases that were considered are 2, 4, 8, 16, and 32 samples. Refractivity fields retrieved using smaller numbers of samples are compared against the reference field, which was obtained using the entire 64-sample data set. It will be shown that, statistically, significant refractivity fields can be obtained from as short as a two-sample dwell. [J1595]

"Mapping the Shallow Water Seabed Habitat With the SHOALS"

The scanning hydrographic operational airborne light detection and ranging (LiDAR) Survey (SHOALS) consists of a bathymetric LiDAR system that provides high-precision measurements of water depth. Although the acquisition is focused on depth accuracy, the return signal, i.e., waveform, contains other relevant information because of integration signatures from the water surface, the water column, and the seabed. This paper highlights the benthic characterization in extracting statistical parameters derived from the bottom backscatter and classifying them. In implementing a specific unsupervised classification, it is significantly proven that the signals derived from habitat, described as statistically homogeneous throughout ground-truth analysis, are similar within an intrahabitat view, whereas they are different between themselves. [J1596]

"Parametric Velocity Synthetic Aperture Radar:Signal Modeling and Optimal Methods"

Velocity synthetic aperture radar (VSAR) is equipped with a linear array to receive the echoes from a radar illuminating area via multiple channels, each of which can reconstruct a reflectivity image for the same stationary scene. Based on analysis of pixel vector sampled among multi-images, VSAR may effectively suppress the strong ground clutter and improve moving target detection and location. In this paper, different Doppler-distributed properties are derived for the moving target and clutter, respectively. Then, we propose a novel parametric statistical model for VSAR by dividing the pixel vector into three components, namely, target, clutter, and noise. Furthermore, a method of adaptive implementation of optimal processing (AIOP-VSAR) is presented for moving target detection. It is shown that the optimum detection performance may be obtained via AIOP-VSAR, particularly for the slowly moving target in an inhomogeneous clutter environment. Also, the Cramer-Rao bounds (CRBs) are derived for the estimation of unknown model parameters, as well as the azimuth locations of moving targets, and the maximum-likelihood methods are proposed to reach these CRBs. Based on the proposed target detection and parameter estimation methods, we present a complete parametric flowchart for VSAR. It is demonstrated that the proposed flowchart may effectively mitigate the "azimuth location ambiguity" of VSAR and has the super-resolution ability to resolve "velocity layover" for multiple targets. Finally, some detailed numerical experiments and scene simulations are provided to show the effectiveness of the proposed methods. [J1597]

"Optimal Two-Stage Search for Sparse Targets Using Convex Criteria"

We consider the problem of estimating and detecting sparse signals over a large area of an image or other medium. We introduce a novel cost function that captures the tradeoff between allocating energy to signal regions, called regions of interest (ROI), versus exploration of other regions. We show that minimizing our cost guarantees reduction of both the error probability over the unknown ROI and the mean square error (MSE) in estimating the ROI content. Two solutions to the resource allocation problem, subject to a total resource constraint, are derived. Asymptotic analysis shows that the estimated ROI converges to the true ROI. We show that our adaptive sampling method outperforms exhaustive search and are nearly optimal in terms of MSE performance. An illustrative example of our method in radar imaging is given. [J1598]

"Information Theory-Based Approach for Contrast Analysis in Polarimetric and/or Interferometric SAR Images"

We propose a new approach for evaluating the contribution of the different channels of polarimetric and interferometric synthetic aperture radar (PolInSAR) images. For that purpose, we demonstrate that the Bhattacharyya distance between the probability density functions of neighboring regions in the image provides an efficient scalar contrast measure. We show that the analysis of this contrast measure allows one to precisely characterize the contribution of each channel for different system configurations, including intensity, polarimetric, and interferometric images. We illustrate this approach using a real synthetic aperture radar image to compare several polarimetric system architectures. Since PolInSAR imaging configurations can correspond to complex and expensive systems, the proposed method can be helpful in system imaging optimization. [J1599]

"AESS meetings"

{no data available} [J1600]

"Segmentation-Based MAP Despeckling of SAR Images in the Undecimated Wavelet Domain"

In this paper, a novel despeckling algorithm based on undecimated wavelet decomposition and maximum aposterioriestimation is proposed. Such a method represents an improvement with respect to the filter presented by the authors, and it is based on the same conjecture that the probability density functions (pdfs) of the wavelet coefficients follow a generalized Gaussian (GG) distribution. However, the approach introduced here presents two major novelties: 1) theoretically exact expressions for the estimation of the GG parameters are derived: such expressions do not require further assumptions other than the multiplicative model with uncorrelated speckle, and hold also in the case of a strongly correlated reflectivity; 2) a model for the classification of the wavelet coefficients according to their texture energy is introduced. This model allows us to classify the wavelet coefficients into classes having different degrees of heterogeneity, so that adhocestimation approaches can be devised for the different sets of coefficients. Three different implementations, characterized by different approaches for incorporating into the filtering procedure the information deriving from the segmentation of the wavelet coefficients, are proposed. Experimental results, carried out on both artificially speckled images and true synthetic aperture radar images, demonstrate that the proposed filtering approach outperforms the previous filters, irrespective of the features of the underlying reflectivity. [J1601]

"A Comparison of Point Target Spectra Derived for Bistatic SAR Processing"

The existence of a double hyperbola in the bistatic range equation makes it difficult to find an exact analytical solution for the 2D point target spectrum. Several approximate solutions for the spectrum have been derived and used to focus bistatic synthetic aperture radar data. In this paper, we establish the relationship between three independently derived bistatic point target spectra. The first spectrum is Loffeld's bistatic formula, which consists of a quasi-monostatic and a bistatic phase term. The second spectrum makes use of Rocca's smile operator, which transforms bistatic data in a defined configuration to a monostatic equivalent. The third spectrum is derived using a power series-called the method of series reversion (MSR). The MSR spectrum is the most general among the three. This paper shows that this spectrum can be reduced to the same formulation as the former two when certain conditions are met. In addition, a new approximate spectrum is derived using a Taylor series expansion about the two stationary phase points of the transmitter and receiver. We also give an alternative geometrical proof of the relationship between Rocca's smile operator and Loffeld's bistatic deformation term. The accuracies of the point target spectra are demonstrated using simulations of an X-band bistatic airborne radar with a fixed baseline. [J1602]

"Beam Sharpening of Delay/Doppler Altimeter Data Through Chirp Zeta Transform"

The main goal of a satellite radar altimeter is to measure the height of the reflecting surface scanned by the passage of the instrument overhead. A delay/Doppler altimeter reduces the along-track footprint size by exploiting the coherence of the emitted pulses to synthetize a narrower antenna. Doppler beam formation is then a straightforward procedure that implies application of the discrete Fourier transform to time-domain bursts. Speckle and thermal noise on Doppler echoes are usually reduced using multilooking, i.e., summing incoherent contributions coming from different bursts. The summation of Doppler beams requires precise pointing toward output sample locations, particularly when highly variable topography is effective. However, the procedure of steering after beam sharpening needs a step of interpolation. In this paper, a Doppler beam sharpening and direction toward the sample position are presented which make use of the Chirp Zeta Transform to join the two operations together. This method must be compared with the existing ones to show that a little can be sacrificed to precision for computational gain. To support the discussion, experimental results will be compared with a precise-and so of reference-direct 2-D correlation algorithm over puntiform targets and more complex scenarios. [J1603]

"Electromagnetic simulation of complex and electrically large structures in WIPL-D Pro [JApplication Notes]"

This article has demonstrated the application of higher order basis functions, smart reduction of expansion orders, and multilevel fast multipole method in efficient 3-D EM simulation of complex and electrically large structures (from compact multiband antenna for wireless applications to 160 lambda long aircraft scatterer) at a desktop computer. [J1604]

"Rotman lens design and simulation in software [JApplication Notes]"

Since its invention in the early 1960s (Rotman and Turner, 1963), the Rotman Lens has proven itself to be a useful beamformer for designers of electronically scanned arrays. Inherent in its design is a true time delay phase shift capability that is independent of frequency and removes the need for costly phase shifters to steer a beam over wide angles. The Rotman Lens has a long history in military radar, but it has also been used in communication systems. This article uses the developed software to design and analyze a microstrip Rotman Lens for the Ku band. The initial lens design will come from a tool based on geometrical optics (GO). A second stage of analysis will be performed using a full wave finite difference time domain (FDTD) solver. The results between the first-cut design tool and the comprehensive FDTD solver will be compared, and some of the design trades will be explored to gauge their impact on the performance of the lens. [J1605]

"MIKON 2008 [JTransnational News]"

The following reports, which are closely related to recent 2008 transnational events of our MTT-S interest, come from two different organizers: Prof. Wojciech Gwarek Г‚Вї presenting the status of MIKON 2008 or 17th International Conference on Microwaves, Radar and Wireless Communications that was held in Poland, and Prof. Zhizhang (David) Chen, giving a snapshot of the lecturing trip of three active MTT-S members in China. I hope that I could receive more reports from you and share them with our colleagues as I know there are many hidden news treasures in the world that should interest our MTT-S members. Before wrapping up my last column in 2008, I wish all of you an innovative and productive new year with excellent health and joyful life. [J1606]

"Recent developments in detection, imaging and classification for airborne maritime surveillance"

The role of maritime patrol missions is to monitor large oceanic areas. The authors focus on a complete signal-processing sequence from the primary detection of the targets to their classification or recognition from an airborne radar. Contrary to the classical approach in which detection, tracking, imaging and classification are considered separately, here the authors propose an integrated strategy based on a close cooperation among all of them. Recent developments in high range resolution target detection are presented and their integration in the complete system is discussed to limit false alarms. High-resolution ISAR imaging of ships is then tackled and associated with a feature extraction process and a support vector machine classifier. A set of real data is used to illustrate the imaging and classification results. [J1607]

"Editorial: Signal processing techniques for ISAR and feature extraction"

Inverse synthetic aperture radar (ISAR) is a non-cooperative target recognition technique that has been investigated for target identification by the combat identification (ID) community for the past decade. Recently, ISAR imaging of moving targets has been an area of vigorous research. ISAR imaging is an effective way to acquire high resolution images of targets of interest at long range and as such is an irreplaceable tool in the task of non-cooperative target recognition. Its applications include detection, imaging, and classification of ships and aircraft with airborne, maritime, and land-based radar systems. Being radar-based, this imaging technique can be employed in all weather and day/night conditions. [J1608]

"A Wavelet-Based Technique for Sea Wind Extraction from SAR Images"

We present the follow-up of our previously published work, where we described a wavelet-based method to characterize the sea surface backscatter structures in Synthetic Aperture Radar (SAR) images. The method relies on the ability of the 2-D continuous wavelet technique to detect the spatial structure of the Marine Atmospheric Boundary Layer (MABL) and to isolate wind-related cells and features. The analysis of the cells' geometry, molded by the radiometric characteristics of the sea surface, permits the identification of the wind direction inside the cells, due to the along-wind asymmetry of backscatter structures, and thus the computation of the wind speed through standard algorithms. Twenty-one SAR images (ERS-2 and Envisat ASAR Wide Swath) over the Mediterranean Sea have been analyzed, and the results are compared with satellite wind fields. The images cover a range of meteorological conditions from low to moderate winds. Comparison of the SAR-derived

wind fields with those provided by satellite scatterometers indicates a good score of success (roughly 70%-80%). The developed methodology, once tested over an adequate number of images to derive statistically reliable results, could be routinely used to enrich SAR images with the wind field as well as to characterize the MABL in terms of size, distribution, and shape of the backscatter cells. [J1609]

"Reducing Credit Re-authorization Cost in UMTS Online Charging System"

During an online charging general packet radio service (GPRS) session, a number of mid-session events, such as changes of quality of service (QoS), could dynamically affect the rating of the in-progress service. When such events occur, the GPRS support node needs to re-authorize the granted credit units with the online charging system (OCS). This paper proposes a threshold-based scheme that utilizes a threshold parameter delta to reduce the signaling traffic for the credit re-authorization procedure. By selecting an appropriate delta value, the signaling overhead in the OCS can be significantly reduced while the inaccuracy of the credit information insignificantly increases. The mobile operator can choose appropriate parameter values in the threshold-based scheme based on our study. [J1610]

"Precise Distance and Velocity Measurement for Real Time Locating in Multipath Environments Using a Frequency-Modulated Continuous-Wave Secondary Radar Approach"

We present a frequency-modulated continuous-wave secondary radar concept to estimate the offset in time and in frequency of two wireless units and to measure their distance relative to each other. By evaluating the Doppler frequency shift of the radar signals, the relative velocity of the mobile units is measured as well. The distance can be measured with a standard deviation as low as 1 cm. However, especially in indoor environments, the accuracy of the system can be degraded by multipath transmissions. Therefore, we show an extension of the algorithm to cope with multipath propagation. We also present the hardware setup of the measurement system. The system is tested in various environments. The results prove the excellent performance and outstanding reliability of the algorithms presented. [J1611]

"Code Design to Optimize Radar Detection Performance Under Accuracy and Similarity Constraints"

This paper deals with the design of coded waveforms which optimize radar performances in the presence of colored Gaussian disturbance. We focus on the class of linearly coded pulse trains and determine the optimum radar code according to the following criterion: maximization of the detection performance under a control on the region of achievable Doppler estimation accuracies, and imposing a similarity constraint with a prefixed radar code. This last constraint is tantamount to requiring a similarity between the ambiguity functions of the devised waveform and of the pulse train encoded with the prefixed sequence. The resulting optimization problem is nonconvex and quadratic. In order to solve it, we propose a technique (with polynomial computational complexity) based on the relaxation of the original problem into a semidefinite program. Thus, the best code is determined through a rank-one decomposition of an optimal solution of the relaxed problem. At the analysis stage, we assess the performance of the new encoding technique in terms of detection performance, region of achievable Doppler estimation accuracies, and ambiguity function. [J1612]

"Accuracy of Bathymetric Assessment by Locally Analyzing Radar Ocean Wave Imagery (February 2008)"

In this paper, the error source in assessing the bathymetry by a recently presented method, the dispersive surface classificator, is discussed. This method is based on the analysis of X-band radar image sequences of sea-surface waves to determine spatial maps of hydrographic parameters. To implement this objective, the radar-deduced bathymetry is validating by multibeam echosounder data. The accuracy of the method is high in homogeneous areas and reduced at the areas of bathymetric gradient and lower but comparable with multibeam echosounder data, under the assumption of the spatial resolution. The identification of systematic correlation of the absolute value of the error with the slope is significant and insignificant with the actual depth itself. The spatial correlation of the error illustrates that the direction of the wave field influences the neighboring grid cell in the same direction. The application of the method during crucial weather conditions is the main advantage and permits the accurate operational nearshore monitoring for several applications. [J1613]

"An Efficient Method to Determine the Diagonal Loading Factor Using the Constant Modulus Feature"

The diagonal loading method is a simple and efficient method that improves the robustness of beamformers. However, determining an ideal diagonal loading factor (DLF) is not a trivial problem, one that still has not been

adequately addressed. Although beamformers are widely used in radar, sonar, and many other applications, in this correspondence, we consider a beamformer used only for digital communication applications. In digital communications, user information is coded into a sequence with the constant modulus (CM) in the baseband. Obviously, if the beamformer can cancel interference sufficiently well, the outputs of the beamformer should satisfy the CM condition more precisely. Therefore, minimizing CM errors can act as a natural criterion for determining DLFs. In this correspondence, we present a cost function based on the criterion. We also propose a direct search algorithm for DLF determination by minimizing the cost function. Numerical experiments show the effectiveness of the proposed method. [J1614]

"Translational rotational motion compensation: a single algorithm for different radar maging applications"

A single algorithm for various radar imaging applications is presented. The idea behind the proposed approach is that any motion between radar and target can always be modelled as a composition of translational and rotational components. Novel techniques to estimate and compensate these two motion components are discussed and also validated by application to real radar data for different targets (ships, aircraft, ground). By the translational-rotational-motion-compensation algorithm, good results can be achieved, especially in cases characterised by evident variation of the rotation rate during the coherent processing time for imaging. This usually happens in aircraft, ship or ground mover inverse synthetic aperture radar (ISAR) imaging as well as in squinted or for.ward-looking SAR. In any case, the efficiency and the accuracy of the algorithm presented for translational motion compensation might be the initial step of alternative radar imaging processing. The simplicity of the proposed algorithms makes them suitable and convenient for real-time application even for compact and low-weight radar systems to be fitted on board unmanned aerial vehicles (UAV) or other airborne platforms. The proposed concept is the result of the authors' decennial experience devoted to achieve a single, simple, robust, reliable and efficient signal processing algorithm for several real-time radar imaging applications. [J1615]

"Micro-Doppler analysis of wheels and pedestrians in ISAR imaging"

In radar imaging, it is well known that relative motion or deformations of parts of illuminated objects induce additional features in the Doppler frequency spectrum. These features are called micro-Doppler effect and appear as sidebands around the central Doppler frequency. They can provide valuable information about the structure of the moving parts and may be used for identification purposes. Previous papers have mostly focused on 1D micro-Doppler analysis. The authors propose to emphasise the analysis of such `non-stationary targets` using a 2D imaging space, using both the micro-Doppler and a high-range resolution analysis. As in 2D-ISAR imaging, range separation enables to better discriminate the various effects caused by the time-varying reflectors. The study is focused on two different common examples: rotating wheels and human motion. With the help of micro-Doppler signature, information on the geometrical features of wheels (position, orientation) and on the gait of pedestrians can be extracted. Examples will be shown with simulated and experimental data. [J1616]

"Doppler signatures of radar backscattering from objects with micro-motions"

Radar backscattering from objects with micro-motions is subject to Doppler modulations that help determine dynamic properties of objects and provide useful information about the objects. Doppler modulations represented by joint time-frequency analysis provide useful time-varying Doppler characteristics and, thus, add additional time-dimension information to exploit motion characteristics. The author discusses how to simulate radar backscattering from objects with rigid body motions and objects with non-rigid body motions, and how to analyse, interpret and characterise Doppler signatures of objects that undergo these micro-motions. Precession heavy top and human locomotion are used as examples of rigid and non-rigid body motions, respectively. Radar micro-Doppler signatures derived from these motions illustrate the potential of the joint time-frequency analysis for exploiting kinetic and dynamic properties of objects. [J1617]

"Polarimetric ISAR autofocusing"

Interest in polarimetric inverse synthetic aperture radar (ISAR) systems has been growing because of their capability to provide extra information about the imaged target compared with single polarisation ISAR systems. Target classification and recognition can be improved by exploiting full polarisation ISAR images. Moreover, full polarisation can be exploited for improving image formation and in particular image autofocusing. Two novel image autofocusing techniques are defined by extending two well-known single polarisation autofocusing techniques, namely the image contrast-based autofocus and image entropy-based autofocus. A performance analysis is carried out by comparing the results obtained by using the extended and the original autofocusing techniques. [J1618]

"Software-Defined Six-Port Radar Technique for Precision Range Measurements"

A software-defined radar measurement system on the basis of a six-port receiver technique is proposed and described in this paper. The system makes use of a hybrid scheme of two performance-complementary operating modes, namely, frequency-modulated continuous-wave (FMCW) and two-tone continuous-wave signals. Generally, the FMCW-based measurement technique is deployed to give an approximate range value of target while the two-tone continuous-wave (CW)-based measurement technique can accurately determine the range that may, however, be ambiguous. The six-port circuit is used for the receiver as a precision phase detector in two-tone CW function and at the same time as a mixer in FMCW function. Various waveforms are generated in direct digital synthesizers and processed by different algorithms in a digital signal processor. The switching between the frequency-modulated CW and two-tone CW functions is controlled by software to improve the resolution and ensure a reliable operation. A system prototype is designed and made for a C-band demonstration. The Schottky diodes used as power detectors in the six-port are calibrated so that they can be used beyond the square-law region, thus allowing a higher power level and a better dynamic range. Measured results validate the proposed software-defined platform and accurate range results are confirmed. [J1619]

"Manoeuvring target motion parameter estimation for ISAR image fusion"

In inverse synthetic aperture radar (ISAR) imaging applications, generating an image of a manoeuvring target is a challenge due to the tradeoff between the fine image resolution requirements and the temporal variability of the Doppler response. The time frequency transform (TFT) is a common method to solve this problem. Prior TFT-based research assumes that the ISAR observes the target from a single fixed aspect. Because of its manoeuvring characteristics, the target motion features are sometimes not extractable from the observing aspect, but become much more distinct from other aspects. ISAR image fusion is thus able to provide significant advantages, since multiple looks of the same target from different aspects will increase the available knowledge. After constructing the common projection plane and building up the physical connection between radars and the manoeuvring target, the parameters that describe the target motion are estimated for very short time duration within which the Doppler response can be assumed to be a constant. Simulation results confirm the effectiveness of the estimation procedure and thus the fusion method. The authors conclude that the ISAR system must be carefully configured in order to realise the full benefits of their image fusion technique for manoeuvring targets. [J1620]

"Two-dimensional ISAR model and image reconstruction with stepped frequency-modulated signal"

A two-dimensional (2-D) inverse synthetic aperture radar (ISAR) return signal model that employs stepped frequency (SF) modulation is developed. The geometry of the examined ISAR scenario is described by analytical geometrical equations. The target to be imaged is represented by a rectangular grid of point scatterers, moving along a rectilinear trajectory at constant speed, without any rotational motion. Thus, the inverse synthetic aperture results from the translational motion of the target for a short period of time. The process of ISAR signal modelling through coherent summation of the SF-modulated signals reflected from different point scatterers of the target is thoroughly described. Moreover, an efficient ISAR image reconstruction approach, including cross-correlation-based range compression and fast-Fourier-transform-based azimuth compression, is presented through analytical mathematical expressions. Numerical simulations are carried out for various SF ISAR scenarios and high-resolution ISAR images are obtained by applying the proposed ISAR image reconstruction approach. Simulation results (ISAR images and corresponding entropy values) indicate the validity of the proposed 2-D SF ISAR return signal model and the efficiency of the proposed imaging algorithms. Finally, a numerical simulation result is illustrated, which shows the comparison of the performance of the proposed ISAR image reconstruction algorithms based on SF and linear frequency modulation waveforms. It is shown that the two waveforms attain almost the same ISAR image resolution. [J1621]

"Motion compensation in ISAR imaging using the registration-restoration-fusion approach"

The distortion in the inverse synthetic aperture radar (ISAR) image of a target is a result of small time-varying perturbed motion experienced by the target during the image integration period and is attributed to a phase modulation effect of the radar return from the target. Large distortion in ISAR images of a moving target has been investigated and demonstrated under controlled experiments and simulation. Results from the analysis suggest that severe distortion is attributed to the phase modulation effect where a time-varying Doppler frequency provides the smearing mechanism. For applications of target identification, the registration-restoration-fusion method has been developed to refocus the distorted ISAR images. This method has been applied to both the experimental and simulated ISAR data. Results demonstrate that the registration-restoration-fusion motion compensation approach can improve the distorted ISAR image better than what can be achieved by conventional Fourier transform methods. This study also adds insight into the distortion mechanisms that affect the ISAR

images of a target in motion. [J1622]

"Detection of a manoeuvring air target in strong sea clutter via joint time-frequency representation"

Two new approaches for detecting a manoeuvring air target in strong sea clutter are proposed. Whereas one is based on the adaptive chirplet decomposition, the other is inspired by spectral subtraction. Unlike the other time-frequency transform-based methods, the approaches presented can both be used to compute a signal's time waveform with suppressed sea clutter. Experiments with real-world data samples show that both methods can effectively enhance the Doppler radar signals associated with a manoeuvring air target by more than 15-dB. [J1623]

"SAR imaging of moving targets using polynomial Fourier transform"

The polynomial Fourier transform (FT) is employed as a tool for the SAR imaging of moving targets. An efficient algorithm is proposed that can be used for radar images containing both moving and stationary targets. The proposed algorithm can be used in the form of the second-order polynomial FT, but it can also be extended to higher-order and order-adaptive polynomial FT forms. [J1624]

"Slope-based frame selection and scaling technique for ship ISAR imaging"

The authors address the problem of optimum imaging time selection and angular motion estimation for ship ISAR or hybrid SAR/ISAR imaging. The aim is to select proper imaging times and to estimate ship angular motion in order to obtain high-quality top view or side view scaled images of the ship, suitable for processing by classification/identification procedures. For this purpose, a new technique is proposed, able to select the time instants better suited for top or side view image formation and to estimate the rotation motion for image scaling. The technique is based on a novel model of the phase/Doppler frequency of the generic ship scatterer and operates entirely in the range-Doppler image domain (as obtained via Fourier transform) by using the slopes of some extracted linear features, thus without requiring coherent processing. The performance of the complete ISAR technique is analysed in depth; the results of the application of the proposed technique to both simulated and live ISAR data prove the effectiveness of the proposed approach. [J1625]

"Real-time motion compensation, image formation and image enhancement of moving targets in ISAR and SAR using S-methodbased approach"

The commonly used technique for inverse synthetic aperture radar (ISAR)/synthetic aperture radar signal analysis is a two-dimensional Fourier transform (FT), which results in an image of the target's reflectivity mapped onto a range and cross-range plane. However, in cases where the line-of-sight projections of the target's point velocities change or there is uncompensated movement within the coherent integration time, the FT produces blurred images. For target recognition applications, mainly those in military surveillance and reconnaissance operations, a blurred ISAR image has to be refocused quickly so that it can be used for real-time target identification. Two standard techniques used for improvement of blurred ISAR images are motion compensation and the use of quadratic time-frequency representations. Both are computationally intensive. The authors present an effective quadratic time-frequency representation, the S-method. This approach performs better than the Fourier transform method by drastically improving images of fast manoeuvring targets and by increasing the SNR in both low and high noise environments. These advantages are a result of the S-method's ability to automatically compensate for quadratic and all even higher-order phase terms. Thus, targets with constant acceleration will undergo full motion compensation and their point scatterers will each be localised. It should be noted that the source of the quadratic term can come not only from acceleration, but also from non-uniform rotational motion and the cosine term in wide-angle imaging. The method is also computationally simple, requiring only slight modifications to the existing FT-based algorithm. The effectiveness of the S-method is demonstrated through application to simulated and experimental data sets. [J1626]

"Passive bistatic radar based on target illuminations by digital audio broadcasting"

A practical passive bistatic radar that is based on target illuminations by digital audio broadcasts is described. As with all such radars, direct signal interference (DSI) is identified as a major limitation, the effect being exacerbated by the multiplicity of illuminators. In addition, such multiplicity can also make the extraction of the original transmitted signal difficult. DSI is reduced by a combination of analogue and digital null formation and isolation by use of cross polarisation. Fast techniques are developed for signal extraction and digital null formation, allowing these operations to be achieved in real time. Both the hardware and algorithms of the system are described and representative radar observations are included to show the systems effectiveness. [J1627]

"A range profiling technique for synthetic wideband radar"

A technique is proposed for reconstructing wide range profiles using stepped-frequency waveforms (SWFs). The technique is based on reconstructing range sub-profiles. With respect to previous methods, the proposed technique can be applied to any kind of SWFs. Moreover, for a given range resolution, long range profiles can be formed without increasing the number of transmitted frequencies. Theoretical results are also derived that provide a correct setting of waveform and processing parameter. Finally, as case studies, the proposed method is applied to three SFWs, namely short-pulse stepped-frequency, linear frequency modulated stepped frequency and phase-coded stepped-frequency waveforms. Simulations prove the effectiveness of the proposed range profile reconstruction. [J1628]

"Fast acquisition implementation for high sensitivity global positioning systems receivers based on joint and reduced space search"

In Global Positioning Systems (GPS), unique pseudorandom codes allow different satellites to share available frequency spectra without interference. In receivers, the locally generated codes (replicas) are correlated with received signals to extract a particular satellite's signal and wipe-off its pseudorandom code. The signals received are generally misaligned with replicas. As a result, receivers search for signals using different codes, code phases, and additional residual sinusoidal demodulations at several possible frequencies. This search is called acquisition and it is computationally challenging for receivers operating under weak signal conditions. Software GPS receivers have been developed over the past several years and continue to be an area of extensive research. Faster, less complex, and more efficient algorithms are required for software GPS receivers. We present a fast algorithm for accelerating acquisition. Several frequency domain approaches proposed by authors earlier are combined to reduce computational complexity. These are (i) joint code, code delay and frequency search; (ii) limited code-phase search; and (iii) a shifting replica approach. Significant gains in arithmetic complexity are achieved. A novel method for restoring correlation degradation introduced by limited code phase search is also presented in this paper. Overall performance of the acquisition is illustrated on different platforms. [J1629]

"Multi-range-resolution radar using inverse filters"

The resolution of a radar range is generally fixed regardless of the detection range. The proposed receiving system for radars is configured with multiple inverse filters so that it has different range resolutions depending on the detection range, and the signal is compressed to a narrow arbitrary pulse width of less than or equal to the reciprocal of the spectrum bandwidth of the transmitted signal. Then the proposed receiving system may be able to have no sidelobes. The frequency response function of each inverse filter used in the receiver is expressed as D(f)/S(f), where D(f) is the Fourier transform of the desired output waveform d(t) and S(f) is the Fourier transform of the transmitted waveform s(t). Specific signal examples are used to clarify what sort of D(f) and S(f) are suitable for preventing D(f)/S(f) from diverging. With regard to this proposed receiving system, a theoretical improvement factor is indicated for the signal-to-noise ratio, and simulations and experiments are conducted to confirm the validity of the proposed receiving system. [J1630]

"Inverse synthetic aperture radar imaging of ship target with complex motion"

High-resolution inverse synthetic aperture radar (ISAR) imaging and recognition of ship target is very important for many applications. Although the principle of ISAR imaging of ship target on the sea is the same as that of flying target in the sky, the former usually has more complex motion (fluctuation with the oceanic waves) than the latter, which makes the motion compensation very difficult. However, the change in phase chirp rate caused by the complex motion of ships will deteriorate the azimuth focusing quality. In this paper, we first model the complex motion of ship target with cubic phase terms (parameterised on chirp rate and its change rate), then a new ISAR imaging method, referred to as TC-DechirpClean, is proposed, which estimates the chirp rate and the change rate of chirp rate of all scatters in the time-chirp distribution plane. Both numerical and experimental results are provided to demonstrate the performance of the proposed method. [J1631]

"Hybrid interference suppression for multistatic radar"

The accurate estimation of a monostatic radar range profile is considered when in the presence of multistatic radar interference for which the illuminating waveforms are assumed known. In an effort to approach the ideal interference-free performance, the range-domain 'beamforming' properties of the recently developed multistatic adaptive pulse compression (MAPC) algorithm is herein combined with the well-known CLEAN algorithm which operates on an interference-subtraction basis. Two versions of this hybridised methodology are presented and compared. To ascertain relative sensitivity, both the mean-squared error and the probability of detection are examined as a function of SNR when in the presence of multistatic interference. It is demonstrated that the

respective merits of MAPC and CLEAN can be used to offset the limitations of the other and thereby combine to provide significant additional sensitivity improvement. [J1632]

"Regional Mapping of the Offshore Wind Resource: Towards a Significant Contribution From Space-Borne Synthetic Aperture Radars"

This paper reviews and discusses the benefits of synthetic aperture radar (SAR) satellite imagery for regional mapping of the offshore wind resources, mostly in comparison to the more standard approach of numerical mesoscale and/or microscale models. Remote sensing measurements can be used as a complementary approach to numerical models, as well as a semi-autonomous approach to assess offshore and coastal wind resources using such methods as the newly developed strategic sampling. An important benefit of using SAR satellite data is to validate numerical model results, and possibly to provide surface wind data to pilot numerical models in coastal regions where observations are scarce. A relatively small sample of SAR scenes can already indicates the best wind sites for offshore wind farms that should be investigated for further analysis. Finally, future challenges facing remote sensing to support the wind energy fields, including new satellites and methodology improvements for the SAR technique, are reviewed. [J1633]

"Measurements of Wind and Turbulence Profiles With Scanning Doppler Lidar for Wind Energy Applications"

High-quality profiles of mean and turbulent statistics of the wind field upstream of a wind farm can be produced using a scanning Doppler lidar. Careful corrections for the spatial filtering of the wind field by the lidar pulse produce turbulence estimates equivalent to point sensors but with the added advantage of a larger sampling volume to increase the statistical accuracy of the estimates. For a well-designed lidar system, this permits accurate estimates of the key turbulent statistics over various subdomains and with sufficiently short observation times to monitor rapid changes in conditions. These features may be ideally suited for optimal operation of wind farms and also for improved resource assessment of potential sites. [J1634]

"Two-Dimensional Multivariate Parametric Models for Radar Applications-Part I: Maximum-Entropy Extensions for Toeplitz-Block Matrices"

In a series of two papers, a new class of parametric models for two-dimensional multivariate (matrix-valued, space-time) adaptive processing is introduced. This class is based on the maximum-entropy extension and/or completion of partially specified matrix-valued Hermitian covariance matrices in both the space and time dimensions. This first paper considers the more restricted class of Toeplitz Hermitian covariance matrices that model stationary clutter. If the clutter is stationary only in time then we deal with a Toeplitz-block matrix, whereas clutter that is stationary in time and space is described by a Toeplitz-block-Toeplitz matrix. We first derive exact expressions for this new class of 2-D models that act as approximations for the unknown true covariance matrix. Second, we propose suboptimal (but computationally simpler) relaxed 2-D time-varying autoregressive models (ldquorelaxationsrdquo) that directly use the non-Toeplitz Hermitian sample covariance matrix. The high efficiency of these parametric models is illustrated by simulation results using true ground-clutter covariance matrices provided by the DARPA KASSPER Dataset 1, which is a trusted phenomenological airborne radar model, and a complementary AFRL dataset. [J1635]

"Spatial Indexes for the Extraction of Formal and Informal Human Settlements From High-Resolution SAR Images"

In this paper, a novel procedure for extracting human settlement extent in high-resolution SAR images, based on local autocorrelation and morphological processing, is presented. The algorithm is based on two steps. Hints for human settlements by information fusion based on local indexes of spatial autocorrelation are the outputs of the first step. A morphological chain builds on top of them the final settlements' borders. Examples from very different areas, i.e., the Darfur region in Sudan and the Lombardy region in Italy, stress the robustness of the procedure as well as its effectiveness. [J1636]

"Two-Dimensional Multivariate Parametric Models for Radar Applications-Part II: Maximum-Entropy Extensions for Hermitian-Block Matrices"

In a series of two papers, a new class of parametric models for two-dimensional multivariate (matrix-valued, space-time) adaptive processing is introduced. This class is based on the maximum-entropy extension and/or completion of partially specified matrix-valued Hermitian covariance matrices in both the space and time dimensions. The first paper considered the more restricted class of Hermitian Toeplitz-block covariance matrices that model stationary clutter. This second paper deals with the more general class of Hermitian-block covariance

matrices that model nonstationary clutter. For our recently proposed 2-D time-varying autoregressive (TVAR) model, we derive optimal and computationally practical suboptimal methods for calculating such parametric models. The maximum-likelihood covariance matrix estimate for the 2-D TVAR model is also derived. The efficacy of the introduced models is illustrated by signal-to-interference-plus-noise ratio (SINR) degradation results obtained when applying the covariance matrix models to space-time adaptive processing filter design, compared with the true clutter covariance matrix provided by the DARPA KASSPER dataset. [J1637]

"Experimental investigation of selective localisation by decomposition of the time reversal operator and subspace-based technique"

The approaches of the active time reversal (TR) selective localisation based on the decomposition of the time reversal operator (DORT) and the TR multiple signal classification (MUSIC) location are presented. The waveguide experiment describes in detail the procedure of active TR location and shows that (i) the extended target could have multiple distinguishable eigenstates, unlike point-like targets in which one target corresponds to one eigenstate; (ii) the selective location can be achieved by means of the standard TR location in the presence of the suspended and bottom objects; (iii) compared with the standard TR location, TR MUSIC location based on signal subspaces performs better in locating non-resolved targets and has lower sidelobe levels to locate the extended target. Finally, the approach of acquiring the TR operator via array probing by weighting Hadamard-Walsh functions (to produce orthogonal beams) is discussed. The experimental result shows that the ambiguity surfaces of the standard TR location and the TR MUSIC location are greatly improved with this approach. [J1638]

"A Wavefront Reconstruction Method for 3-D Cylindrical Subsurface Radar Imaging"

In recent years, the use of radar technology has been proposed in a wide range of subsurface imaging applications. Traditionally, linear scan trajectories are used to acquire data in most subsurface radar applications. However, novel applications, such as breast microwave imaging and wood inspection, require the use of nonlinear scan trajectories in order to adjust to the geometry of the scanned area. This paper proposes a novel reconstruction algorithm for subsurface radar data acquired along cylindrical scan trajectories. The spectrum of the collected data is processed in order to locate the spatial origin of the target reflections and remove the spreading of the target reflections which results from the different signal travel times along the scan trajectory. The proposed algorithm was successfully tested using experimental data collected from phantoms that mimic high contrast subsurface radar scenarios, yielding promising results. Practical considerations such as spatial resolution and sampling constraints are discussed and illustrated as well. [J1639]

"Slant Plane CSAR Processing Using Householder Transform"

Fourier analysis-based focusing of synthetic aperture radar (SAR) data collected during circular flight path is a recent advancement in SAR signal processing. This paper uses the Householder transform to obtain a ground plane circular SAR (CSAR) signal phase history from the slant plane CSAR phase history by inverting the linear shift-varying system model, thereby circumventing the need for explicitly computing a pseudo-inverse. The Householder transform has recently been shown to have improved error bounds and stability as an underdetermined and ill-conditioned system solver, and the Householder transform is computationally efficient. [J1640]

"A Recursive Filter for Despeckling SAR Images"

This correspondence proposes a recursive algorithm for noise reduction in synthetic aperture radar imagery. Excellent despeckling in conjunction with feature preservation is achieved by incorporating a discontinuity-adaptive Markov random field prior within the unscented Kalman filter framework through importance sampling. The performance of this method is demonstrated on both synthetic and real examples. [J1641]

"Interworking of WLAN-UMTS networks: an IMS-based platform for session mobility"

In this article a framework for interworking between a WLAN and the UMTS is presented. The uniqueness of this architecture is that the IP multimedia subsystem proposed by the 3GPP has been used as an arbitrator for network coupling and real-time session management. Apart from the advantage of a cellular network user being able to enjoy higher levels of bandwidth over a WLAN, IMS also provides a common platform for unified session control, as well as higher levels of terminal and service mobility over a heterogeneous networking environment. The article concludes by presenting the potential of this model for service continuity during and after vertical handoff with simulation results for validation. [J1642]

"Economy microwave spectrum analyzers"

Anritsu Company introduces new options for its MS271xB series that take advantage of the economy microwave spectrum analyzers' best-in-class phase noise of -110 dBc/Hz at 10 kHz offset (typical, 800 MHz) and make it easier to integrate the instruments into legacy manufacturing environments. The MS271xB series has been designed to accurately measure the performance of wireless broadband components and devices, increase production yields, and lower the cost of production test. [J1643]

"Synergetic Use of Radar and Optical Satellite Images to Support Severe Storm Prediction for Offshore Wind Farming"

In this paper, we show how satellite images taken by space-borne radar sensors can be used to determine mesoscale high-resolution wind fields in synergy with cloud parameters from optical data and, thus, help in the task of maintenance and planning offshore wind farms. The aim of this paper is to use synthetic aperture radar (SAR) and medium resolution imaging spectrometer (MERIS) onboard the environmental satellite (ENVISAT) in synergy to analyze severe weather systems, in particular, to describe the spatial evolution of the atmospheric boundary layer processes involved in cold air outbreaks. We investigated the fine-scale structure of a severe weather case on November 1, 2006 over the North Sea using satellite data. The satellite data are compared with numerical model results of the German Weather Service ldquoLokal Modellrdquo (LM) and the high-resolution limited area model (HIRLAM). LM and HIRLAM show differences in mesoscale turbulent behavior and coastal shadowing. Maximum wind speeds of up to 25 m/s are measured by SAR and are confirmed by the models. Significant differences are observed in the location of the maxima. High-resolution ENVISAT ASAR measurements provide very detailed information on small-scale atmospheric features, which seem to not be captured well by the analyzed numerical models, in particular, in coastal areas. Meteosat second generation (MSG) is used to determine the movement of cloud patterns. Cloud patterns seen in the optical data and radar cross-section modulation give a consistent dynamical picture of the atmospheric processes. The relevance for offshore wind farming is discussed. [J1644]

"Linearly constrained minimum-'normalised variance' beamforming against heavy-tailed impulsive noise of unknown statistics"

A new beamforming approach to combat the arbitrary unknown heavy-tailed impulsive noises including all alpha-stable noises with infinite variance or infinite mean is presented. The new approach, termed as linearly constrained minimum-'normalized variance' beamformer (LCMNV), is formulated as one to minimise the normalised variance of the beamformer's output, subject to a pre-specified set of linear constraints. The normalised variance is defined as a pseudo-correlation function of the instantaneously adaptive, infinity-norm snapshot-normalised data, as an alternative to the customary 'fractional lower-order moments' (FLOM) for heavy-tailed impulsive noise environments. The proposed beamformer is in essence second-order statistics based, and produces an instantaneously scaled beamformer output. The LCMNV beamformer outperforms the FLOM beamformer with the following advantages: (i) computationally simpler with a closed-form solution, (ii) requiring no prior information or estimation of the effective characteristic exponents of the impulsive noises, (iii) applicable to a wider class of heavy-tailed impulsive noises and (iv) offering better interference-rejection ability. [J1645]

"Theoretical limits on SAR imposed by the ionosphere"

The ultimate theoretical limitations on space-based synthetic aperture radar (SAR) image formation that are imposed by the ionosphere are examined. The effects on the SAR image are derived from first principles, and it is shown that the ionosphere will cause defocusing in both the range and along track directions. The performance of an autofocus procedure is then examined, and it is shown that the range defocusing can always be removed, but the range time delay can only be determined for high percentage bandwidths and high signal-to-noise plus clutter ratios. It is also shown that the performance limits of autofocus are not determined by the absolute total electron content, but are given by the amount of ionospheric turbulence, which limits the along track resolution. The relationship between the requirement for a focussed SAR image and the S4index and the integrated strength of turbulence CkLis derived. [J1646]

"Radar detection based on Bayesian estimation of target amplitude"

A new approach to detect a target with an unknown amplitude in clutter is proposed. The received signal models under two hypotheses, H0and H1, are assumed to be the same, except that the target amplitude is zero under H0. Using the Bayesian approach, it is shown that the likelihood ratio can be calculated as the ratio of the prior to posterior probabilities of the target amplitude. Based on this relation, a new method for target detection in Gaussian clutter is presented. This method is applied to cases with both known and unknown clutter statistics and in each case, white and coloured clutters are considered. Simulation results show that the proposed detector

has a much better performance compared with conventional generalised likelihood ratio test detectors. [J1647]

"Monitoring Urban Land Cover in Rome, Italy, and Its Changes by Single-Polarization Multitemporal SAR Images"

This study contributes an assessment of the potential of single-polarization decametric synthetic aperture radar (SAR) images in classifying land cover within and around large urban areas and in monitoring their changes. The decision task is performed on a pixel basis and is carried out by supervised neural network algorithms fed by radar image features including backscattering intensity, coherence and textural parameters. Two configurations are considered: a short-term classification and change detection scheme intended for providing information in near-real time and a long-term scheme aimed at observing the urban changes at year time scales. We use a pair of interferometric images for the short-term case, while the long-term exercise utilizes two interferometric pairs and a fifth single acquisition. The images are acquired by the ERS SAR in late winter, spring and early summer over 836 square kilometers including Rome, Italy, and its surroundings. The accuracy of the short-term algorithm in discriminating seven types of surface is higher than 86%, while the accuracy of the long-term algorithm is beyond 88%. The many changes undergone by Rome from 1994 to 1999 have been identified by the postclassification comparison change detection procedure. The pixel-by-pixel analysis of the results has been carried out for a 160 square kilometers test area, obtaining a correct detection above 82% (less than 18% missed alarms and 0.3% false alarms). [J1648]

"Errata [Jto "Peacetime Radio Astronomical Measurements Using World War II Radar Equipment" (Jun 08 148-153)]"

In the above titled paper (ibid., vol 9, no. 3, pp. 148-153), the photographs for Figures 1 and 3 were switched. The correct photographs and labels are presented here. [J1649]

"Spectral Clustering Ensemble Applied to SAR Image Segmentation"

Spectral clustering (SC) has been used with success in the field of computer vision for data clustering. In this paper, a new algorithm named SC ensemble (SCE) is proposed for the segmentation of synthetic aperture radar (SAR) images. The gray-level cooccurrence matrix-based statistic features and the energy features from the undecimated wavelet decomposition extracted for each pixel being the input, our algorithm performs segmentation by combining multiple SC results as opposed to using outcomes of a single clustering process in the existing literature. The random subspace, random scaling parameter, and Nystrom approximation for component SC are applied to construct the SCE. This technique provides necessary diversity as well as high quality of component learners for an efficient ensemble. It also overcomes the shortcomings faced by the SC, such as the selection of scaling parameter, and the instability resulted from the Nystrom approximation method in image segmentation. Experimental results show that the proposed method is effective for SAR image segmentation and insensitive to the scaling parameter. [J1650]

"Least Squares-Based Filter for Remote SensingImage Noise Reduction"

The Vondrak filter is a unique technique for smoothing data. The filter aims to achieve a balance between the fidelity and the smoothness of the filtered results. It can therefore preserve the original attributes of the observational data while, at the same time, smooth out the noise. We reformulate the 1-D Vondrak filter that has been widely used in data processing in fields such as astronomy and geophysics and then extend it into two dimensions. The method of conjugate gradients is used to solve the least squares optimization problem. The proposed 2-D filter is a powerful tool for enhancing the quality of various geoscience and remote sensing data such as satellite images. Various tests with simulated and real synthetic aperture radar interferograms show that the new filter is very effective in removing the noise. [J1651]

"Simultaneous Noncontact Measurement of Water Level and Conductivity"

Measurement of water level and conductivity is important in many applications, including geophysics, ocean engineering, and the oil industry, with one example being gas/oil/water separation. Noncontact measurement is ideal for those applications. Capacitance, radar, ultrasonic, and laser techniques have been used in measuring the level, but simultaneous measurements of level and conductivity have not been reported. In this paper, we developed a novel inductive sensor, which uses two coils of different sizes to simultaneously infer conductivity and level based on a simplified model deduced from an analytical solution. The simplified model is verified with both simulation and experimental data. The experimental results have shown that the measurement accuracy for both level and conductivity is within 3%. [J1652]

"Fast and Accurate Computation of the Myriad Filter via Branch-and-Bound Search"

The myriad filter has demonstrated to be a robust countermeasure against the negative effect that impulsive noise has over electronic systems. However, its use is still limited in systems where processing speed is critical, as is the case of radar, sonar, and real-time audio and video processing. This limitation has its roots in the challenges imposed by the numerical approximation of the myriad filter. In particular, minimization operations at the interior of nonlinear operations are sensitive components that have a direct impact on the performance of the filtering algorithms. In the case of the myriad filter, the minimization of functions with multiple local minima is a common operation, and poorly chosen algorithms compromise the good behavior of the filter. In this correspondence, we present an alternative for the minimization of the objective function in the computation of the myriad filter. This solution exploits general concepts in global optimization and adapts them to the particular case of myriad filtering. This technique improves accuracy and speed in the computation of the myriad filter, making the method feasible in many problems. [J1653]

"Higher-Order SVD-Based Subspace Estimation to Improve the Parameter Estimation Accuracy in Multidimensional Harmonic Retrieval Problems"

Multidimensional harmonic retrieval problems are encountered in a variety of signal processing applications including radar, sonar, communications, medical imaging, and the estimation of the parameters of the dominant multipath components from MIMO channel measurements. R-dimensional subspace-based methods, such as R-D Unitary ESPRIT, R-D RARE, or R-D MUSIC, are frequently used for this task. Since the measurement data is multidimensional, current approaches require stacking the dimensions into one highly structured matrix. However, in the conventional subspace estimation step, e.g., via an SVD of the latter matrix, this structure is not exploited. In this paper, we define a measurement tensor and estimate the signal subspace through a higher-order SVD. This allows us to exploit the structure inherent in the measurement data already in the first step of the algorithm which leads to better estimates of the signal subspace. We show how the concepts of forward-backward averaging and the mapping of centro-Hermitian matrices to real-valued matrices of the same size can be extended to tensors. As examples, we develop the R-D standard Tensor-ESPRIT and the R-D Unitary Tensor-ESPRIT algorithms. However, these new concepts can be applied to any multidimensional subspace-based parameter estimation scheme. Significant improvements of the resulting parameter estimation accuracy are achieved if there is at least one of the Rdimensions, which possesses a number of sensors that is larger than the number of sources. This can already be observed in the two-dimensional case. [J1654]

"Bounds for Estimation of Covariance Matrices From Heterogeneous Samples"

This correspondence derives lower bounds on the mean-square error (MSE) for the estimation of a covariance matrix mbi Mp, using samples mbi Zk,k=1,...,K, whose covariance matrices mbi Mkare randomly distributed around mbi Mp. This framework can be encountered e.g., in a radar system operating in a nonhomogeneous environment, when it is desired to estimate the covariance matrix of a range cell under test, using training samples from adjacent cells, and the noise is nonhomogeneous between the cells. We consider two different assumptions for mbi Mp. First, we assume that mbi Mpis a deterministic and unknown matrix, and we derive the Cramer-Rao bound for its estimation. In a second step, we assume that mbi Mpis a random matrix, with some prior distribution, and we derive the Bayesian bound under this hypothesis. [J1655]

"Rao-Blackwellised particle filter based trackbefore- detect algorithm"

A track-before-detect (TBD) algorithm based on the Rao-Blackwellised particle filter (RBPF) is proposed for over-the-horizon radar (OTHR) target detection and tracking. Since the unthresholded measurements are integrated over time in the TBD algorithm, it can potentially detect and track targets with a much lower signal-to-noise ratio than conventional methods. In order to take advantage of the TBD algorithm, both system dynamic and measurement models are defined for the application under consideration. Furthermore, by exploiting the linear sub-structure available in the models, an RBPF based TBD algorithm is derived in detail. The proposed algorithm can provide reduced variance for the estimates with linear sub-structure and a lower computational complexity than the standard particle filter. Simulation results show that the proposed algorithm is capable of detecting and tracking dim targets for OTHR efficiently. [J1656]

"Focusing Azimuth-Invariant Bistatic SAR Data With Chirp Scaling"

This letter presents a bistatic chirp scaling algorithm to processing the azimuth-invariant bistatic synthetic aperture radar data. Two methods are used to derive the different parts of the range-Doppler expression of the point target. Compared with the method relying on the two-order expansion of the bistatic range model, the new algorithm can give the close-form azimuth modulation. Through the introduction of the fractional Fourier transform into the range processing, the resolutions are enhanced further. [J1657]

"Classification of Ground Clutter and Anomalous Propagation Using Dual-Polarization Weather Radar"

This paper presents the results of a study designed to classify weather radar clutter echoes obtained from ground-based dual-polarization weather radar systems. The clutter signals are due to ground clutter, sea clutter, and anomalous propagation echoes, which represent sources of error in quantitative radar rainfall estimation. Fuzzy and Bayes classifiers are evaluated as an alternative approach to traditional polarimetric-based methods. Both systems were trained and validated by using C-band dual- polarization radar measurements, and a novel technique is proposed to calculate the texture function to mitigate against the edge effects at the boundaries of precipitation regions. A methodology is presented to extract the membership functions and conditional probability density functions to train the classifiers. The critical success index indicates that the Bayes classifier has, on average, a slightly better performance than the fuzzy classifiers. However, when optimal weighting was applied, the fuzzy classifier gave one of the best performances. The classifiers are sufficiently robust to be used when only single-polarization radar measurements are available. [J1658]

"A New Approach for Simultaneous Range Measurement and Doppler Estimation"

To circumvent the dilemma of range and Doppler ambiguity in the conventional pulsed Doppler radars, a stepped time interval pulse train (STIPT) scheme is proposed in this letter. The STIPT approach eliminates range and Doppler ambiguities by setting the pulse interval difference appropriately. The range sidelobes are removed through a modified aperiodic correlation algorithm. Furthermore, the fast Fourier transform can be used in the Doppler processing. Consequently, the newly proposed approach can be applied to the conventional pulsed radar systems. [J1659]

"Phase-Based Clutter Identification in Spectra of Weather Radar Signals"

A novel method for suppression of ground clutter (GC) in weather radar is presented. The novel identification scheme is entirely phase based, unlike power-based schemes that are generally used. GC contributions to the Doppler spectrum are identified from the differential phase between complex spectral coefficients of two spectra estimated for odd- and even-indexed half-sequences of the original time series. Phase values near zero are used as indicators of clutter contributions for Doppler bins close to zero velocity. Indicated Doppler bins are notched from the original spectrum, and the moments are then obtained. The identification scheme is motivated by spectra of an electronically steered phased array of the National Weather Radar Testbed (NWRT) and requires a sufficient number of pulses/samples for spectral analyses. However, the method can be used with a mechanically steered antenna with an appropriate adjustment compensating smearing due to antenna rotation. The method was tested on several NWRT data sets obtained in clear air and in precipitation. One example of clutter-filtered power in precipitation is shown here. There is no baseline for comparison, as the NWRT does not have clutter filtering at the present time. Nonetheless, for a comparison of power- and phase-based identification schemes, a power-based clutter filter similar to the one used by the National Weather Service on the network of mechanically steerable Weather Surveillance Doppler radars WSR-88Ds is implemented on NWRT and used as a preliminary baseline for comparison. [J1660]

"UWB radar for human being detection [Jsame as "UWB radar for human being detection", ibid., vol. 21, n. 11, 06]"

UWB radar for detection and positioning of human beings in a complex environment has been developed and manufactured. The novelty of the radar lies in its large operational bandwidth (11.7 GHz at -10 dB level) combined with high time stability. Detection of respiratory movement of a person in laboratory conditions has been demonstrated. Based on experimental results, human being radar return has been analysed in the frequency band from 1 GHz to 12 GHz. The novel principle of human being detection is considered and verified experimentally. [J1661]

"Validation of the Submetric Accuracy of Vertical Positioning of PSs in C-Band"

The permanent scatterers (PSs) technique is an operational tool in the context of spaceborne synthetic aperture radar interferometry for monitoring the displacement of radar targets with millimetric accuracy. Recently, the target localization capability of the PS technique has been subject of study, and the possibility of generating digital elevation models (DEMs) and digital terrain models (DTMs) by means of the height of a sparse set of points has been evaluated. In this letter, for the first time, the PS height estimate has been validated by exploiting about 250,000 spot heights at street level derived from photogrammetric techniques in the urban area around Milan, Italy. The very high correlation between the two independent measurements confirms the theoretical submetric accuracy of vertical positioning. A multitrack PS DTM has then been generated and

compared to the spot heights together with the corresponding Shuttle Radar Topography Mission (SRTM) DEM, showing the very high improvement given by the PS technique to the freely available topographic data. The results have been obtained by processing about 300 European Space Agency (ESA) European Remote Sensing (ERS) satellite and Envisat images acquired from two descending tracks and an ascending one over Milan. [J1662]

"Interactive Dynamic Range Reduction for SAR Images"

The visualization of synthetic aperture radar (SAR) data involves the mapping from high dynamic range amplitude values to gray values of a lower dynamic range display device. This dynamic range reduction process controls the amount of information in the displayed result and is therefore an important part of each SAR visualization system. Interactive systems provide the user with immediate feedback on the changes of the reduction method and its parameters. In this letter, we examine different dynamic range reduction techniques known from the tone mapping of optical images. The techniques are analyzed, regarding their applicability to SAR data, and incorporated into our interactive visualization framework based on programmable graphics hardware. [J1663]

"Fisher Distribution for Texture Modeling of Polarimetric SAR Data"

The multilook polarimetric synthetic aperture radar (PolSAR) covariance matrix is generally modeled by a complex Wishart distribution. For textured areas, the product model is used, and the texture component is modeled by a Gamma distribution. In many cases, the assumption of Gamma-distributed texture is not appropriate. The Fisher distribution does not have this limitation and can represent a large set of texture distributions. As an example, we examine its advantage for an urban area. From a Fisher-distributed texture component, we derive the distribution of the complex covariance matrix for multilook PolSAR data. The obtained distribution is expressed in terms of the KummerU confluent hypergeometric function of the second kind. Those distributions are related to the Mellin transform and second-kind statistics (Log-statistics). The new KummerU-based distribution should provide in many cases a better representation of textured areas than the classic Kdistribution. Finally, we show that the new model can discriminate regions with different texture distribution in a segmentation experiment with synthetic textured PolSAR images. [J1664]

"Sea Ice Deformation State From Synthetic Aperture Radar Imagery-Part II: Effects of Spatial Resolution and Noise Level"

C- and L-band airborne synthetic aperture radar (SAR) imagery acquired at like- and cross-polarizations over sea ice under winter conditions is examined with the objective to study the discrimination between level ice and ice deformation features. High-resolution low-noise data were analyzed in the first paper. In this second paper, the main topics are the effects of spatial resolution and signal-to-noise ratio. Airborne high-resolution SAR scenes are used to generate a sequence of images with increasingly coarser spatial resolution from 5 to 25 m, keeping the number of looks constant. The signal-to-noise ratio is varied between typical noise levels for airborne imagery and satellite data. Areal fraction of deformed ice and average deformation distance are determined for each image product. At L-band, the retrieved values of the areal fraction get larger as the image resolution is degraded. The areal fraction at C-band remains constant. The retrieved average distance between deformation features increases both at C- and L-bands as the image resolution gets coarser. The influence of noise becomes noticeable if its level is equal or larger than the average intensity backscattered from the level ice. The retrieval of deformation parameters using simulated images that resemble ERS-2 SAR, Envisat ASAR, and ALOS PALSAR data products is discussed. Basic differences between real and simulated ERS-2 SAR images are analyzed. [J1665]

"A Two-Dimensional Spectrum Model for General Bistatic SAR"

This paper derives a 2-D spectrum model for general bistatic synthetic aperture radar (SAR). By introducing some new parameters such as equivalent monostatic parameters, bistatic factor, and weighted-equivalent range, the 2-D spectrum of general bistatic SAR can be expressed in the form of monostatic SAR even when the transmitter and receiver move along unparallel trajectories with different velocities. The result formulates bistatic SAR into an equivalent monostatic SAR model and would be useful for developing efficient bistatic SAR algorithms in frequency-domain or hybrid-domain processing. Simulation results are given to validate the performance of the model. For special bistatic SAR configurations, the model can be simplified. Compared to other similar models, the proposed model is clearer and much more concise. [J1666]

"A Bistatic Point Target Reference Spectrum for General Bistatic SAR Processing"

A bistatic point target reference spectrum (BPTRS) based on Loffeld's bistatic formula (LBF) is derived in this

letter. For LBF, the same contributions of the transmitter and receiver to the total azimuth modulation are assumed. This assumption results in the failure of LBF in the extreme configuration (i.e., spaceborne/airborne configuration). For general bistatic configurations, the azimuth modulations are unequal for the transmitter and receiver due to the different slant ranges and velocities. Therefore, the azimuth time-bandwidth products (TBPs) from the transmitter and receiver are different; in some cases (e.g., spaceborne/airborne case), one of them might be very small, which might even result in a serious error of the principle of stationary phase. This letter uses TBP to weight the azimuth phase modulation contributions of the transmitter and receiver to the common azimuth spectrum to approximately obtain the point of stationary phase of the total azimuth phase history. Simulations show that the proposed BPTRS can work well for spaceborne/airborne configurations. [J1667]

"Exact Maximum Likelihood Estimates for SIRV Covariance Matrix: Existence and Algorithm Analysis"

In this paper, we investigate the existence and the algorithm analysis of an adaptive scheme that has been introduced for covariance structure matrix estimation in the context of adaptive radar detection under non-Gaussian noise. This latter has been modeled by spherically invariant random vector (SIRV), which is the product c of the square root of a positive unknown random variable tau and an independent Gaussian vector x,c=radic(tau) x. A similar line of work was undertaken in the context of compound Gaussian noise, and this paper extends the previous results in the case of SIRV modeled noise. More precisely, the fixed-point estimate to be studied verifies a nonlinear algebraic equation (E)x=f(x). The aim of this paper is twofold. First, we prove that (E) admits a unique solution x; secondly, we show that the corresponding iterative algorithm xn+1=f(xn) converges to x for every admissible initial condition. [J1668]

"Wideband synthetic aperture beamforming for through-the-wall imaging [JLecture Notes]"

Through-the-wall radar imaging (TWRI) and sensing is emerging as an important area of research and development. A TWRI system provides enhanced situational awareness in operational environments for a variety of civilian and military applications. In particular, a TWRI system facilitates realtime information gathering and intelligent decision-making about the contents of the indoor scene. Compared to other radar applications, TWRI faces unique challenges due to signal propagation through walls. The composition and thickness of the wall, its dielectric constant, and the angle of incidence affect the strength and characteristics of the propagating signal. The change in propagation speed and wave refraction must be taken into account for effective and accurate imaging. In this article, we present a synthetic aperture beamforming approach that uses ray perturbation theory to account for the effects of transmission through a single uniform wall. [J1669]

"Generalized High-Order Phase Function for Parameter Estimation of Polynomial Phase Signal"

The high-order phase function (HPF) has been introduced recently to estimate the parameters of a polynomial phase signal (PPS). In this correspondence, we generalize the standard HPF by introducing multiple time instants. Thus, the standard HPF can be treated as a special example of the generalized HPF with identical time instants. We propose a procedure for finding time instants minimizing the mean-square error (MSE). The proposed method achieves better performances than the high-order ambiguity function (HAF) and polynomial Wigner-Ville distribution (PWVD). The theoretical analysis as well as the Monte Carlo simulations verify the advantages such as lower MSE and lower SNR threshold for the PPS. [J1670]

"Ant colony optimisation for tree-searching-based synthesis of monopulse array antenna"

The design of simple feed networks is of great interest in synthesising monopulse radar array antennas in order to reduce the complexity of the antenna architecture, the costs as well as the occupied physical space (e.g. on aircraft). Sub-arraying techniques have been proposed to properly address such a task. Starting from the formulation of the sub-arraying problem in terms of a combinatorial one, the final compromise solution is obtained by looking for the minimum cost path inside a binary tree graph through an ant colony optimiser. [J1671]

"An Approach to the Measurement of Microwave Frequency Based on Optical Power Monitoring"

A novel approach to the measurement of microwave frequency based on optical power monitoring is proposed and demonstrated. The microwave signal with its frequency to be measured is modulated on two optical carriers with their wavelengths set at one peak and one valley of the spectral response of a sinusoidal filter. The modulation is performed by a Mach-Zehnder modulator that is biased to suppress the optical carriers. A mathematical expression relating the optical powers from the two wavelength channels and the microwave frequency to be measured is developed. By simply monitoring the optical powers at the outputs of the two

wavelength channels, the microwave frequency can be evaluated. A proof-of-concept experiment is implemented. Frequency measurement with good accuracy for microwave signals at different power levels is realized. [J1672]

"Optimal Particle Filters for Tracking a Time-Varying Harmonic or Chirp Signal"

We consider the problem of tracking the time-varying (TV) parameters of a harmonic or chirp signal using particle filtering (PF) tools. Similar to previous PF approaches to TV spectral analysis, we assume that the model parameters (complex amplitude, frequency, and frequency rate in the chirp case) evolve according to a Gaussian AR(1) model; but we concentrate on the important special case of a single TV harmonic or chirp. We show that the optimal importance function that minimizes the variance of the particle weights can be computed in closed form, and develop procedures to draw samples from it. We further employ Rao-Blackwellization to come up with reduced-complexity versions of the optimal filters. The end result is custom PF solutions that are considerably more efficient than generic ones, and can be used in a broad range of important applications that involve a single TV harmonic or chirp signal, e.g., TV Doppler estimation in communications, and radar. [J1673]

"Angle estimation using ESPRIT in MIMO radar"

It is shown that ESPRIT exploits the invariance property of both the transmit array and the receive array in a bistatic MIMO radar to estimate the target's direction. Some numerical results are presented to verify the effectiveness of this method. [J1674]

"Scanning Laser Radar-Based Target Position Designation for Parking Aid System"

Recently, customers have shown a growing interest in parking aid products. A parking aid system consists of target position designation, path planning, and parking guidance by user interface or path tracking by active steering. For target position designation, various sensors and signal processing technologies have been tried. In the case of parallel parking, an ultrasonic sensor-based method plays a dominant role. In the case of perpendicular parking, a graphical user interface (GUI)-based method and a parking slot marking-based method have been commercialized. However, methods developed for the recognition of free parking space between vehicles have their respective drawbacks. This paper proposes a method for the recognition of free parking space between vehicles using scanning laser radar. This proposed method consists of range data preprocessing, corner detection, and target parking position designation. The authors developed a novel corner-detection method consisting of rectangular corner detection and round corner detection. The newly developed corner detection is unaffected by cluster orientation and the range data interval and is robust to noise. Experimental results showed that even in situations where other methods failed, the proposed scanning laser radar-based method could designate target parking position to viable free parking space. The recognition rate was 98.21%, and the average processing time was about 600 ms. Finally, it is argued that the proposed method will eventually be a practical solution because of the decreasing price of scanning laser radar and multiple-function integration strategies. [J1675]

"Radar Handbook, 3rd Edition (M.I. Skolnik, Ed; 2008) [JBook Review]"

Thirty eight radar experts contribute to this edition, which includes six completely new chapters on the following topics: ground penetrating radar; remote sensing with radar on satellites; multifunctional radar systems for fighter aircraft (MFAR); digital signal processing for radar; civil marine radar; and propagation. Each chapter contains references, ranging from 10 to 197, with a median of 71. The index runs 18 pages printed in double columns, but is not necessarily complete. Some topics, such as MIMO radar and long range radars to track satellites and ballistic missiles, will have to wait for a 4th edition. This text is the most authoritative, broadest, and deepest single volume on radar. The emphasis is on real world performance and real hardware that has been tested and works successfully in the real world, and the physics relevant to radar systems, as well as radar system engineering cost tradeoffs. [J1676]

"William M. Brown [JObituary]"

Recounts the life and career of William M. Brown, former Radar Editor of the IEEE Transactions on Aerospace and Electronic Systems, who passed away earlier this year. [J1677]

"An Improved Adaptive Sidelobe Blanker"

We propose a two-stage detector consisting of a subspace detector followed by the whitened adaptive beamformer orthogonal rejection test. The performance analysis shows that it possesses the constant false alarm rate property with respect to the unknown covariance matrix of the noise and that it can guarantee a wider

range of directivity values with respect to previously proposed two-stage detectors. The probability of false alarm and the probability of detection (for both matched and mismatched signals) have been evaluated by means of numerical integration techniques. [J1678]

"Transmit beamforming for MIMO radar systems using signal cross-correlation"

Proposed next-generation radar systems will have multiple transmit apertures with complete flexibility in the choice of the signals transmitted at each aperture. Here we propose the use of multiple signals with arbitrary cross-correlation matrix R, and show that R can be chosen to achieve or approximate a desired spatial transmit beampattern. Two specific problems are addressed. The first is the constrained optimization problem of finding the value of R which causes the true transmit beampattern to be close in some sense to a desired beampattern. This is approached using convex optimization techniques. The second is the problem of designing multiple constant-modulus waveforms with given cross-correlation R. The use of coded binary phase shift keyed (BPSK) waveforms is considered. A method for finding the code sequences based on random signaling with a structured correlation matrix is proposed. It is also shown that by restricting the class of admissible waveforms one reduces the set of possible signal correlation matrices. [J1679]

"Characterization of Inclusions in a Nonhomogeneous GPR Problem by Artificial Neural Networks"

This paper aims at detecting and characterizing inclusions in concrete structures by inverting ground-penetrating radar (GPR) data. First, the signal is preprocessed using the principal component analysis (PCA) and then used to train an artificial neural network (ANN). The GPR data consists of 1200 time steps. Using PCA, the data can be compressed to 286 dimensions without losing any information. Moreover, with 99.99% of the original variance the data needs only 139 dimensions. This dimensional reduction makes the ANN training easier and faster. The ANN were trained to find the buried inclusions characteristics-and-considering a nonhomogenous host medium by inverting the preprocessed data. The results show that the expected maximum error was kept under 1%, which is a remarkable result, since the host medium is nonhomogenous. [J1680]

"Waveform Synthesis for Diversity-Based Transmit Beampattern Design"

Transmit beampattern design is a critically important task in many fields including defense and homeland security as well as biomedical applications. Flexible transmit beampattern designs can be achieved by exploiting the waveform diversity offered by an array of sensors that transmit probing signals chosen at will. Unlike a standard phased-array, which transmits scaled versions of a single waveform, a waveform diversity-based system offers the flexibility of choosing how the different probing signals are correlated with one another. Recently proposed techniques for waveform diversity-based transmit beampattern design have focused on the optimization of the covariance matrix of the waveforms, as optimizing a performance metric directly with respect to the waveform matrix is a more complicated operation. Given an, obtained in a previous optimization stage or simply pre-specified, the problem becomes that of determining a signal waveform matrix whose covariance matrix is equal or close to, and which also satisfies some practically motivated constraints (such as constant-modulus or low peak-to-average-power ratio constraints). We propose a cyclic optimization algorithm for the synthesis of such an, which (approximately) realizes a given optimal covariance matrix under various practical constraints. A numerical example is presented to demonstrate the effectiveness of the proposed algorithm. [J1681]

"Comments on "Discrete Frequency-Coding Waveform Design for Netted Radar Systems""

For original paper see H. Deng, ibid., vol.11, no.2, p.179-182, (2004). This comment points out some errors in the correlation calculations and conclusions in the literature. The ambiguity function and cross-ambiguity function for discrete frequency-coding waveform (DFCW) with arbitrary firing order are analyzed in that letter to corroborate the judgement. It shows that range autocorrelation sidelobe peak (ASP) for DFCW fluctuates around 0.21, the Doppler tolerance has sinc function form, while the range cross-correlation peak (CP) between two DFCWs is heavily varied with the different firing order. The correlation values are recalculated. [J1682]

"Breast Surface Estimation for Radar-Based Breast Imaging Systems"

Radar-based microwave breast-imaging techniques typically require the antennas to be placed at a certain distance from or on the breast surface. This requires prior knowledge of the breast location, shape, and size. The method proposed in this paper for obtaining this information is based on a modified tissue sensing adaptive radar algorithm. First, a breast surface detection scan is performed. Data from this scan are used to localize the breast by creating an estimate of the breast surface. If required, the antennas may then be placed at specified distances from the breast surface for a second tumor-sensing scan. This paper introduces the breast surface estimation and antenna placement algorithms. Surface estimation and antenna placement results are demonstrated on three-dimensional breast models derived from magnetic resonance images. [J1683]

"Effect of Salinity on the Dielectric Properties of Geological Materials: Implication for Soil Moisture Detection by Means of Radar Remote Sensing"

We consider the exploitation of dielectric properties of saline deposits for the detection and mapping of moisture in arid regions on both Earth and Mars. We present simulated and experimental study in order to assess the effect of salinity on the complex permittivity of geological materials and, therefore, on the radar backscattering coefficient in the [1-7 GHz] frequency range. Laboratory measurements are performed on sand/sodium chloride aqueous mixtures using a vectorial network analyzer coupled to an open-ended coaxial dielectric probe. We aim at calibrating and validating semiempirical dielectric mixing models. In particular, we evaluated the dependence of the real and imaginary parts of complex permittivity on the microwave frequency, water content, and salinity. Our results confirm that if the real part is mainly affected by the moisture content, the imaginary part is more sensitive to salinity. In addition to the classic formulas of mixing models, the ionic-conductivity losses, which are due to mobile ions in the saline solution, are taken into account in order to better assess the effect of salinity on the dielectric properties of mixtures. Dielectric mixing models are then used as input parameters for the simulation of the radar backscattering coefficients by means of an analytical model: the integral equation model. Simulation results show that salinity should have a significant impact on the radar backscattering recorded in synthetic aperture radar data in terms of the magnitude of the backscattering coefficient. Moreover, our results suggest that VV polarization provides a greater sensitivity to salinity than HH polarization. [J1684]

"Interference Cancellation for High-Frequency Surface Wave Radar"

The performance of high-frequency surface wave radar (HFSWR) is known to suffer from external environmental interference and noise, such as cochannel radio-frequency interference from other radiating source, ionospheric clutter, lightning impulsive noise, etc. This paper experimentally evaluates the interference cancellation performance of various adaptive beamforming schemes with respect to the aforementioned three types of interferences in an attempt to find the most promising adaptive cancellation scheme in practical HFSWR environment. [J1685]

"PRISM: An In-Vehicle CPU-Oriented Novel Azimuth Estimation Technique for Electronic-Scan 76-GHz Adaptive-Cruise-Control Radar System"

In this paper, we have developed a novel azimuth- estimation technique for 76-GHz adaptive-cruise-control radar systems. To resolve the rank deficiency of the signal covariance matrix and to decrease the influence of dominant noise components, we used an improved SS technique. To balance computational cost with azimuth resolution for in-vehicle implementation, we introduced a projection matrix kernel, which formally is similar to that of beamforming (BF) and semantically similar to that of the propagator method. Our technique is called the PRopagator method based on an improved spatial-smoothing matrix (PRISM). Incorrectly estimating the number of targets causes the conventional BF, subspace-based (SB), or maximum- likelihood methods to produce many false spectrum peaks on the relative azimuth-to-distance plane. We omitted the process of estimating the number of targets, which requires high computational power, because our projection matrix kernel strongly suppresses these false peaks. We conducted numerical experiments using an electronic-scan radar system to examine the performance of PRISM. Compared to conventional SB methods, PRISM requires SNRs that are 2-3 dB higher but has competitive azimuth resolution at a centesimal fraction of the computational cost. [J1686]

"Signal Radiation and Power Losses of Time-Modulated Arrays"

We review and formalize the mathematical background of time-modulated linear arrays (TMLAs); then, a number of issues are examined. First, for signal transmission applications, restrictions to the frequencies involved in the procedure are highlighted. Second, the sideband power losses associated to the technique are thoroughly examined, introducing a coefficient appropriate to evaluate the efficiency of the procedure. Finally, a closed form expression for the total power associated to sideband radiation is obtained, very convenient for the implementation of real-time optimization of the system. Relevance of additional research on the subject is highlighted. [J1687]

"Bounds on the Volume and Height Distributions for the MIMO Radar Ambiguity Function"

The multiple-input multiple-output (MIMO) radar delay-Doppler ambiguity function is introduced as the sum of all auto- and cross-ambiguity functions of the set of K spatially diverse waveforms. The integral of this function over the range-Doppler frequency region occupied by spread clutter relates to the clutter's power at the output of the matched MIMO receiver, and it serves as a measure of orthogonality of the waveforms in this region. We derive the upper bound on the attainable "clear area" for the ambiguity function, and we show that, with respect to the

conventional single-waveform ambiguity function, the maximum clear area is K times smaller for the MIMO system. [J1688]

"Latest trends in radar system testing"

Radar systems were initially limited to military applications, but today most people encounter radar applications everyday. Given the broad range of applications, a variety of radar types and technologies have emerged to meet unique needs. This paper discusses about the latest advances on system performance and testing of radar systems. When performing characterization of a radar receiver design, a variety of signals are required to accurately recreate the operational environment. This paper will review the test signal environment needed for evaluation of various modern radar systems. Performance considerations in terms of signal source fidelity and spectral purity will also be investigated. [J1689]

"A 5GHz Double-Sideband Radar Sensor Chip in 0.18 m CMOS for Non-Contact Vital Sign Detection"

A 5 GHz double-sideband radar sensor chip for non-contact vital sign detection was designed and fabricated in UMC 0.18 mum mixed-mode/radio frequency CMOS process. The transceiver was designed with a differential architecture. Measurements show that it has over 1 GHz tuning range, and can successfully detect both the respiration and the heartbeat signals of a human subject. It is also shown that the differential architecture has the advantage of reducing local oscillation leakage. The 5 GHz double-sideband system can avoid null detection point by frequency tuning. [J1690]

"High-Resolution Through-the-Wall Radar Imaging Using Beamspace MUSIC"

The MUSIC algorithm is a high-resolution direction finding technique which has been successfully applied to enhance radar imaging in inverse synthetic aperture radar (ISAR). Although this signal subspace-based method has proven effective when dealing with point targets and high signal-to-noise ratio (SNR), it may fail to work when directly applied to extended targets or target returns of low SNR. The Beamspace MUSIC (BS-MUSIC), in which the MUSIC algorithm is applied to multiple beams, is capable of locating spatially extended targets in low SNR environments. In this paper, we consider BS-MUSIC as an image formation method for indoor radar imaging problems and sensing through-the-wall applications. We compare BS-MUSIC performance to conventional beamforming and element-space MUSIC. Imaging results, using both synthesized and real data, demonstrate the advantages of the proposed algorithm in depicting targets behind walls. [J1691]

"Fast Computation of the Nonlocal Boundary Condition in Finite Difference Parabolic Equation Radiowave Propagation Simulations"

Finite difference parabolic equation method (FD-PEM) codes using a nonlocal boundary condition to model radiowave propagation over electrically large domains, require the computation of time consuming spatial convolution integrals. For the first time, we propose the use of recursive convolution (RC) with vector fitting (VF) to reduce this computational burden. RC is based on the ability to express functions as a sum of exponential terms. This is achieved using the VF method. Details of the RC formulation applied in a two-dimensional (2D) Wide-angle FD-PEM (WA-FD-PEM) are presented together with 2D simulations which demonstrate the computational speed and accuracy of the synthesized RC-WA-FD-PEM code. [J1692]

"Spectral moment estimation of an extended target in ULA"

We consider the problem of estimating the algebraic spectral moments of an extended target in a radar with uniform linear array (ULA). A new algorithm is proposed which is based on the series representation of the covariance matrix [1] and a least-squares fit on the elements of the covariance matrix [2]. The method is shown to provide accurate estimates of the spectral moments. The estimate realization does not need a priori knowledge of the receiver noise power. [J1693]

"Distributed sensing based on intelligent sensor networks"

Network centric approach to complex systems has been attracting a lot of attention in the recent past. With specific applications in space, military and other information enterprises, such an approach is capable of yielding autonomy at the system level. This article describes a distributed approach to information processing in sensor networks. The network architecture entails a hierarchy of capabilities, information and control, where nodes in the network are thoroughly or partially autonomous. The network also consists of slave nodes dedicated to sensing and gathering information. Individual nodes are expected to possess resources for networking and computing and presume autonomy through multi functional modules for sensory processing and situation assessment. Data

association, registration and fusion are formulated into a joint process, and an expectation maximization (EM) approach is developed to solve the three problems simultaneously. A fuzzy cognitive map (FCM) is proposed to perform situation assessment, while a genetic algorithm (GA) is applied for learning, to identify an optimal structure. The distributed architecture is applied to coastal surveillance with simulations on the west coast of Canada. [J1694]

"A Subspace-Based Adaptive Sidelobe Blanker"

We propose a modified version of the adaptive sidelobe blanker (ASB) consisting of a generalized likelihood ratio test (GLRT)-based subspace detector followed by the adaptive coherence estimator. The performance analysis shows that it possesses the constant false alarm rate property with respect to the unknown covariance matrix of the noise in homogeneous environment and that it guarantees a wider range of ldquodirectivityrdquo values with respect to the plain ASB. The probability of false alarm and the probability of detection (the latter for matched signals only) have been evaluated in closed form in homogeneous environment and by resorting to Monte Carlo simulation for the other considered cases. [J1695]

"Improvement of Image Segmentation Accuracy Based on Multiscale Optimization Procedure"

This letter proposes an optimization approach that enhances the quality of image segmentation using the software Definiens Developer. The procedure aims at the minimization of over- and undersegmentations in order to attain more accurate segmentation results. The optimization iteratively combines a sequence of multiscale segmentation, feature-based classification, and classification-based object refinement. The developed method has been applied to various remotely sensed data and is compared to the results achieved with the established segmentation procedures provided by the Definiens Developer software. The quantitative assessment of segmentation accuracy based on reference objects is derived from an aerial image, and a high-resolution synthetic aperture radar scene shows an improvement of 20%-40% in object accuracy by applying the proposed procedure. [J1696]

"Reverberations: peacetime radio astronomical measurements using World War II radio equiptment"

First Page of the Article [J1697]

"Synchronization-based scheme for calculating ambiguity functions of wideband chaotic signals"

This paper develops a synchronization-based scheme for calculating ambiguity function (AF) of a wideband chaotic signal. In the direct implementation, the formulation of the time-scaling chaotic signal takes much computational load and its accuracy determines the quality of the calculated AF diagrams. By exploring the generation of the chaotic signal, the impulsive synchronization theory can be used to produce its time-delay and time-scaling versions. With this observation, the AF diagrams can be accurately obtained by following correlation operation. A distinct characteristic of the proposed scheme is that the generation of the time-delay and time-scaling versions is implemented in an analog way, while the correlation operation can be implemented in a digital way. This mixed analog-digital structure provides the proposed scheme with implementation advantages and practical applicability. [J1698]

"A Low-Power High-Sensitivity X-Band Rail SAR Imaging System [JMeasurement's Corner]"

Wideband radar imaging with range gating and high sensitivity can be achieved with the use of low-cost commercially available narrowband IF filters. Such filters reduce the effective receiver noise bandwidth of the radar system. This allows for high sensitivity, comparable to that of single-sideband radio receivers, while at the same time acquiring de-chirped wide-band received waveforms. A carefully developed radar architecture, based on the use of these IF filters, is shown in this paper. This radar architecture is then implemented in an X-band linear rail synthetic-aperture-radar (SAR) imaging system. The X- band rail SAR is a linear FM-chirped radar, which chirps from approximately 7.5 GHz to 12.5 GHz. The radar front end is mounted onto an eight-foot-long linear rail. The transmitted power is adjustable to 10dBm or less. It will be shown that objects as small as groups of pushpins in free space can be imaged using transmitted power as low as 10 nW. These results are compared to previous direct-conversion X-band FMCW rail SAR work. A high-sensitivity X-band rail SAR such as this could be useful for measuring low-radar-cross-section (RCS) targets. This radar could be used in high clutter environments that require a range gate. This low-power X-band rail SAR could be useful for operation in restricted transmission areas, where maximum radiated power is severely limited. Other applications include any that require low transmitter power, such as automotive radar. [J1699]

"Memeber of the Research Staff"

{no data available} [J1700]

"A Sophisticated Parallel MLFMA for Scattering by Extremely Large Targets [JEM Programmer's Notebook]"

The development of the MLFMA for realistic targets is currently at the stage where clever implementation, using a series of tricks based on the characteristics of the MLFMA and current computer technology, is required. A sophisticated parallel MLFMA for use on distributed-memory computers is presented as a whole picture of developing the program using a style of multilevel development in this paper. A series of implementation tricks for the parallel MLFMA are analyzed and compared. Particularly, a novel trick for reducing the truncation numbers is presented for extremely large targets, in the paper. These tricks are integrated into a sophisticated parallel MLFMA. The memory requirement and the CPU time for each part in each level are analyzed numerically by typical numerical experiments. The capability of this sophisticated parallel MLFMA is demonstrated by computing scattering by a sphere with a diameter of 480 wavelengths, containing around 130 million unknowns, and for a plane model with a fuselage of more than 1000 wavelengths, containing more than 72 million unknowns. These are the largest scattering problems ever solved by full-wave numerical methods, to our knowledge. [J1701]

"Our Other Contributions"

{no data available} [J1702]

"Characterization of Passive UHF RFID Tag Performance"

This paper deals with the characterization of passive ultra-high-frequency (UHF) radio-frequency identification (RFID) tag performance. The tag's energy-harvesting properties, and the significance of the backscattered signal strength and radar cross section (RCS) of the tag, are discussed using two examples: dipole tag antennas of various widths, and identification of industrial paper reels. [J1703]

"On the Correlated -Distribution With Arbitrary Fading Parameters"

The correlated bivariate K-distribution with arbitrary and not necessarily identical parameters is introduced and analyzed. Novel infinite series expressions for the joint probability density function and moments are derived for the general case where the associated bivariate distributions, i.e., Rayleigh and gamma, are both arbitrary correlated. These expressions generalize previously known analytical results obtained for identical parameter cases. Furthermore, considering independent gamma distributions, the cumulative distribution and characteristic functions are analytically obtained. Although the derived expressions can be used in a wide range of applications, this letter focuses on the performance analysis of dual branch diversity receivers. Specifically, the outage performance of dual selection diversity receivers operating over correlated K fading/shadowing channels is analytically evaluated. Moreover, for low normalized outage threshold values, closed-form expressions are obtained. [J1704]

"Radar Cross Section (RCS) Modeling and Simulation, Part 2: A Novel FDTD-Based RCS Prediction Virtual Tool for the Resonance Regime"

A novel FDTD-based virtual radar cross section (RCS) prediction tool is introduced. Characteristic examples using simple three-dimensional structures, as well as more-realistic complex air and surface targets, are presented. The virtual tool automatically constructs a wire-grid model of the structure under investigation. It is therefore also possible to compare FDTD results against MoM-based NEC (Numerical Electromagnetics Code) data. It is shown that this virtual tool can be used for both educational and research purposes. [J1705]

"Study of Millimeter-Wave Radar for Helicopter Assisted-Landing System"

Landing helicopters on rough unprepared terrain has always been considered hazardous, since the massive dust cloud generated by wind drafts from the helicopter's rotors completely obstructs the pilot's view of the landing area. This article presents a performance assessment of a proposed millimeter-wave (MMW) three-dimensional imaging radar system, specifically meant for helicopter assisted landing. The assessment includes simulation of radar backscattering from the underlying rough terrain, in addition to the signal attenuation and scattering from dust clouds generated by the helicopter's rotors. Terrain scattering is simulated in two steps: 1) generation of a two-scale random rough surface according to prescribed statistics of a large-scale undulation and a small-scale surface roughness; and 2) simulation of the returned signal, including the effects of the real-aperture radar

parameters and the terrain-backscatter response. Details of the three-dimensional imaging algorithm are presented. Single-scattering theory is used to simulate the effects of a dust cloud-including signal attenuation and backscatter clutter generation-on the radar's performance. It is shown that operating in the upper millimeter-wave regime (70 GHz-220 GHz) is the most practical solution for a compact, high-resolution, three-dimensional imaging system for this problem. [J1706]

"Short Courses"

{no data available} [J1707]

"Dynamic Radar Cross Section and Radar Doppler Measurements of Commercial General Electric Windmill Power Turbines Part 1: Predicted and Measured Radar Signatures"

Commercial windmill-driven power turbines ("wind turbines") are expanding in popularity and use in the commercial power industry, since they can generate significant electricity without using fuel or emitting carbon-dioxide ldquogreenhouse gasrdquo. In-country and near-off-shore wind turbines are becoming more common on the European continent. The United States has recently set long-term goals to generate 10% of national electric power using renewable sources. In order to make such turbines efficient, current 1.5 MW wind-turbine towers and rotors are very large, with blades exceeding 67 m in diameter, and tower heights exceeding 55 m. Newer 4.5 MW designs are expected to be even larger. The problem with such large, moving, metallic devices is the potential interference such structures present to an array of civilian air-traffic-control radars. A recent study by the Undersecretary of Defense for Space and Sensor Technology acknowledged the potential performance impact wind turbines introduce when located within line of site of air-traffic-control or air-route radars [Report to the Congressional Defense Committees on The Effect of Windmill Farms On Military Readiness, 2006]. In the spring of 2006, the Air Force Research Laboratory embarked on a rigorous measurement and prediction program to provide credible data to national decision makers on the magnitude of the signatures, so that the interference issues could be credibly studied. This paper, the first of two parts, will discuss the calibrated RCS measurement of the turbines, and compare this data (with its uncertainty) to modeled data. [J1708]

"AMTA Corner"

{no data available} [J1709]

"Institutional Listings"

{no data available} [J1710]

"Sparse Representation in Structured Dictionaries With Application to Synthetic Aperture Radar"

Sparse signal representations and approximations from overcomplete dictionaries have become an invaluable tool recently. In this paper, we develop a new, heuristic, graph-structured, sparse signal representation algorithm for overcomplete dictionaries that can be decomposed into subdictionaries and whose dictionary elements can be arranged in a hierarchy. Around this algorithm, we construct a methodology for advanced image formation in wide-angle synthetic aperture radar (SAR), defining an approach for joint anisotropy characterization and image formation. Additionally, we develop a coordinate descent method for jointly optimizing a parameterized dictionary and recovering a sparse representation using that dictionary. The motivation is to characterize a phenomenon in wide-angle SAR that has not been given much attention before: migratory scattering centers, i.e., scatterers whose apparent spatial location depends on aspect angle. Finally, we address the topic of recovering solutions that are sparse in more than one objective domain by introducing a suitable sparsifying cost function. We encode geometric objectives into SAR image formation through sparsity in two domains, including the normal parameter space of the Hough transform. [J1711]

"A Consistent Metric for Performance Evaluation of Multi-Object Filters"

The concept of a miss-distance, or error, between a reference quantity and its estimated/controlled value, plays a fundamental role in any filtering/control problem. Yet there is no satisfactory notion of a miss-distance in the well-established field of multi-object filtering. In this paper, we outline the inconsistencies of existing metrics in the context of multi-object miss-distances for performance evaluation. We then propose a new mathematically and intuitively consistent metric that addresses the drawbacks of current multi-object performance evaluation metrics. [J1712]

"Diversity-Integration Tradeoffs in MIMO Detection"

In this paper, a multiple-input multiple-output (MIMO) detection problem is considered. At first, we derive the generalized likelihood ratio test (GLRT) for arbitrary transmitted signals and arbitrary time-correlation of the disturbance. Then, we investigate design criteria for the transmitted waveforms in both power-unlimited and power-limited systems and we derive closed-form formulas for the probability of false alarm and the detection probability. Finally, we study the interplay among the rank of the optimized space-time code (i.e., the number of linearly independent transmitted waveforms), the number of transmit diversity paths generated in the signal space, and the amount of energy integrated along each path. The results confirm that there is an inherent tradeoff between diversity and integration, and that no uniformly optimum waveform design strategy exists. [J1713]

"Detecting the presence of psk signals using composite hypothesis testing"

In this paper, we study the problem of signal- presence detection, assuming a generic source transmission which can consist of separate pilot and data portions, in the high-power regime. In particular, we derive the optimum non- decision-directed test for the signal-presence hypothesis, which universally applies to all PSK data modulation strategies. For wireless fading channels, the optimum decision test is obtained by computing and thresholding a new proposed decision statistic: the "hybrid" non-coherent accumulation. Hybrid accumulation combines magnitude and power accumulations of the received antenna data, across multiple coherence intervals, or multiple coherence bands. All findings in this paper are derived theoretically, and subsequently verified using computer simulations. [J1714]

"Computing and bounding the first-order Marcum Q-function: a geometric approach"

A geometric interpretation of the first-order Marcum Q-function, Q(a,b), is introduced as the probability that a complex, Gaussian random variable with real mean a, takes on values outside of a disk CO,bof radius b centered at the origin O. This interpretation engenders a fruitful approach for deriving new representations and tight, upper and lower bounds on Q(a,b). The new representations obtained involve finite-range integrals with pure exponential integrands. They are shown to be simpler and more robust than their counterparts in the literature. The new bounds obtained include the generic exponential bounds which involve an arbitrarily large number of exponential functions, and the simple erfc bounds which involve just a few erfc functions, together with exponential functions in some cases. The new generic exponential bounds approach the exact value of Q(a,b) as the number of exponential terms involved increases. These generic exponential bounds evaluated with only two terms and the new simple erfc bounds are much tighter than the existing exponential bounds in most cases, especially when the arguments a and b are large. Thus, in many applications requiring further analytical manipulations of Q(a,b), these new bounds can lead to some closed-form results which are better than the results available so far. [J1715]

"Signal Synthesis and Receiver Design for MIMO Radar Imaging"

Multiple-input-multiple-output (MIMO) radar is an emerging technology that has significant potential for advancing the state-of-the-art of modern radar. When orthogonal waveforms are transmitted, with M+N(Ntransmit and Mreceive) antennas, an MN-element filled virtual array can be obtained. To successfully utilize such an array for high-resolution MIMO radar imaging, constant-modulus transmit signal synthesis and optimal receive filter design play critical roles. We present in this paper a computationally attractive cyclic optimization algorithm for the synthesis of constant-modulus transmit signals with good auto- and cross-correlation properties. Then we go on to discuss the use of an instrumental variables approach to design receive filters that can be used to minimize the impact of scatterers in nearby range bins on the received signals from the range bin of interest (the so-called range compression problem). Finally, we present a number of numerical examples to demonstrate the effectiveness of the proposed approaches. [J1716]

"Analysis of surface micro machined RF MEMS phase shifters"

Development of low loss radio frequency micro-electro-mechanical (MEMS) phase shifters for radar and telecommunication applications is presented. Numerical simulation results using electromagnetic simulator tools (CST-Germany) along with fabricated wafer level measurement results of two distributed MEMS phase shifters are presented herein for upstate capacitive bridge position. The distributed MEMS phase shifter consists of coplanar waveguide (CPW) transmission line and several MEMS bridges loading capacitively on transmission lines to create a slow wave structure. Two configurations of phase shifters are presented. 1) Conventional distributed MEMS transmission line (DMTL) 2) coplanar waveguide-microstrip-coplanar waveguide (CPW-MS-CPW), with microstrip as the transmission line and CPW as input and output line. The electromagnetic simulation results of gap height variation to change the phase velocity and, in turn, phase shift is presented. Work is underway to vary the gap height between transmission line and the bridge, applying the actuation voltage to

bridge capacitors, which, in turn, will vary the bridge capacitance, changing the phase velocity on fabricated phase shifters. The match between simulated results and wafer level measurements are encouraging and will be presented in the full paper. Work is also underway to validate wafer level measurements along with numerical simulation using circuit models using circuit simulator. The custom model libraries for phase shifters are being developed. The results are encouraging. [J1717]

"Errors analysis of transponder-based radiometric calibration for high-resolution imaging radars"

Calibration is often required for precision measurement instruments like synthetic aperture radar (SAR) such that an image pixel intensity is directly expressed in terms of the surface backscatter coefficient. An active reflector named as transponder is an effective SAR calibration device which yields a larger radar cross-section than a corner reflector. Likewise, encoding the retransmitted signal can decouple the transponder from the background scatterers, hence, it can be used to calibrate SAR for radiometry, polarimetry and interferometry. However, as this transponder acts as an amplitude modulator, any signal errors in the transponder will result in degraded performance of radiation calibration. Literature search reveals that little work has been reported. As such, various kinds of signal errors and their effects on radiometric calibration are investigated. The system configuration and corresponding signal processing algorithms are detailed. Starting with an investigation of different errors, closed analytic expressions for calibration performance are derived. Furthermore, the most essential element of this transponder, one X-band wideband voltage-controlled attenuator, is developed. Experimental results show that, because of its low cost and wideband modulation technique, this transponder has extensive applications, not just for radiometric calibration. [J1718]

"Wavelet Contribution to Remote Sensing of the Sea and Target Detection for a High-Frequency Surface Wave Radar"

High-frequency waves (3-30 MHz) interact with the sea surface. Thus, a high-frequency surface wave radar (HFSWR) is well suited to perform remote sensing of the sea. The HFSWR coverage range is not limited by the radio horizon: it is possible to keep watch over the sea up to a few hundred kilometers from the coastline. Oceanographic parameters (i.e., wave height, surface current velocity, wind direction, and wind velocity) are derived from the so-called sea spectrum. Moreover, the HFSWR can be used for maritime surveillance of the Exclusive Economic Zone. In that case, the sea spectrum is an unwanted signal because it can mask targets. Sea spectrum extraction is an important issue for HFSWR signal processing since it is a key point for the remote sensing accuracy and the target detection features. In this letter, we show how wavelets may be applied to improve the remote sensing of oceanographic parameters and the target detection using wavelet-based sea clutter extraction. The results obtained using real data with opportune targets validate our approach. [J1719]

"CramЙr-Rao Bounds for Multiple Poles and Coefficients of Quasi-Polynomials in Colored Noise"

In this paper, we provide analytical expressions of the Cramer-Rao bounds for the frequencies, damping factors, amplitudes, and phases of complex exponentials in colored noise. These expressions show the explicit dependence of the bounds of each distinct parameter with respect to the amplitudes and phases, leading to readily interpretable formulae, which are then simplified in an asymptotic context. The results are presented in the general framework of the polynomial amplitude complex exponentials (PACE) model, also referred to as the quasi-polynomial model in the literature, which accounts for systems involving multiple poles and represents a signal as a mixture of complex exponentials modulated by polynomials. This work looks further and generalizes the studies previously undertaken on the exponential and the quasi-polynomial models. [J1720]

"On Binary Probing Signals and Instrumental Variables Receivers for Radar"

The so-called merit factor approach (MFA) to radar binary sequence design has led to several theoretical contributions in fairly diverse research areas including information theory, computer science, combinatorial optimization, and analytical number theory. However, the MFA-which basically aims at minimizing the clutter effect on radar performance-implicitly assumes the use of a least squares (LS) receiver that is optimal only when there is no clutter. This problem can be eliminated by using a more general optimal instrumental-variables (IV) receiver in lieu of the LS receiver. The IV receiver can reject clutter more efficiently than the LS receiver. Additionally, the binary sequence design problem associated with the IV approach has an interesting form. [J1721]

"Determination of Bathymetric and Current Maps by the Method DiSC Based on the Analysis of Nautical X-Band Radar Image Sequences of the Sea Surface (November 2007)"

Morphodynamic processes in coastal areas are affected by tidal currents and sea state. The continuous

observation of near coastal areas is important in order to monitor dangerous current-regime and bathymetry changes. Therefore, there is an urgent need for remote sensing techniques delivering the important hydrographic parameters with a high spatial resolution. Dispersive surface classificator (DiSC) is a newly developed method based on the analysis of nautical X-band radar image sequences of sea surface waves to determine spatial maps of hydrographic parameters, e.g., spatial maps of the bathymetry and the ocean current field. The method DiSC is described and is illustrated by the presentation of results based on a dataset acquired with a ground-based X-band radar installation mounted on the Island of Sylt in the German Bight. The calculated bathymetric maps are verified by multibeam echo sounder observations. [J1722]

"Through-Wall Tracking of Human Movers Using Joint Doppler and Array Processing"

In this letter, a radar combining Doppler processing and spatial beamforming is presented for tracking humans through walls. Multiple targets are tracked by resolving the targets in the Doppler and bearing space. To overcome the high sidelobes associated with an array of limited size, the CLEAN and RELAX algorithms are implemented, and their performances are compared with standard beamforming. The radar is tested in indoor line-of-sight and through-wall scenarios for multiple loudspeakers and human subjects. [J1723]

"Spatial and Temporal Scaling Behavior of Surface Shortwave Downward Radiation Based on MODIS and In Situ Measurements"

In this letter, a new Moderate Resolution Imaging Spectroradiometer (MODIS)-based 5-km surface shortwave downward (SWD) radiation data set is used to examine the spatial scaling behavior of the surface radiative fluxes. In situ measurements of SWD radiation at time scales from 5 to 55 min from the Oklahoma MesoNet and the Baseline Surface Radiation Network sites over the U.S. are employed to examine the temporal scaling behavior of surface downward radiation and to evaluate the estimates based on MODIS observations from both Terra and Aqua platforms. Analysis reveals that the surface SWD radiation derived from MODIS Terra is in better agreement with ground observations than those from MODIS Aqua. Spatial scaling behavior is investigated based on the MODIS-derived SWD radiation at scales varying from 5 to 100 km. The root mean square difference and the mean standard deviation are found to be highly correlated with the scale exhibiting a strong log-linear relationship. This is a first study on the scaling behavior for surface SWD. Such information is expected to provide linkage between different satellite-based radiation data sets including those derived from geostationary satellites usually of coarser spatial resolutions. [J1724]

"Uncertainty-Aware Design Criteria for the Classification of Sensor Data"

The design of low-cost distributed real-time classifiers whose inputs are the physical data from the environment is an issue of major interest in the emerging technology of so-called smart sensors. When a classifier has to be implemented on low-power and low-cost platforms, a tradeoff between classification accuracy and implementation complexity must be pursued. Here, a multiobjective optimization approach will be introduced to jointly minimize both the classification error rate and the platform resource usage. Objective evaluation is then a critical issue because design decision making is based on that. In practice, objective estimation is usually affected by uncertainty, which has to be taken into account in the design process. Here, we will consider the uncertainty that originates from the reduced size of the manually classified (labeled) data sets, which form the sole source of information used to build a learning-from-examples classifier. Then, the design criteria that make direct use and even try to take advantage of such uncertainty will be proposed. The proposed approach is validated using both synthetic and real-world data sets. [J1725]

"A low cost GSM/GPRS based wireless home security system"

Home security system is needed for occupants' convenience and safety. In this paper, we present the design and implementation of a low cost, low power consumption, and GSM/GPRS (global system for mobile communication /general packet radio service) based wireless home security system. The system is a wireless home network which contains a GSM/GPRS gateway and three kinds of wireless security sensor nodes that are door security nodes, infrared security nodes and fire alarm nodes. The nodes are easy installing. The system can response rapidly to alarm incidents and has a friendly user interface including a LCD (liquid crystal display) and a capacitive sensor keyboard. The wireless communication protocol between the gateway and the nodes is also suitable for other home appliances. Furthermore, some methods are taken to ensure the security of system information. [J1726]

"Potential Effects of the Ionosphere on Space-Based SAR Imaging"

There has been a considerable interest in the use of lower frequency (VHF/UHF) space-based synthetic aperture radar (SAR) for realizing the foliage and ground penetration. The phase perturbation, signal distortion and

imaging resolution degradation by the ionosphere will be particularly severe, however the model is not yet well established and still needs to be further studied. In this paper, on the basis of possible improvements for the model proposed by Ishimaru and others, potential ionospheric effects on SAR imaging are evaluated. First, for analyzing azimuthal resolution, we apply the fourth moment recently obtained in general case of strong fluctuation regimes, which is expected to give results for wider conditions. The Gaussian approximation was used in the previous model; however it is only valid in the fully saturated regimes. Second, for analyzing image shift and distortion, besides group delay, the higher-order dispersion is considered. Third, for discussing range resolution degraded due to pulse broadening, besides the dispersion, the multiple scattering of ionospheric turbulence is studied. Fourth, the Faraday rotation effect is analyzed. Numerical simulations are shown using ionospheric turbulence spectrum and TEC inferred from the International Reference Ionosphere (IRI) and satellite beacon observations. [J1727]

"Nathanson Award to Marina Sabrina Greco"

Dr. Maria Sabrina Greco was awarded the 2007 Fred Nathanson Memorial Radar Award "for contributions to signal processing, estimation, and detection theory." [J1728]

"SAR for disaster management"

In the last couple of years, an indigenous airborne synthetic aperture radar for disaster management (DMSAR) has been under development at SAC / ISRO, as a capacity building measure for evolving an effective disaster management support (DMS) system in India. Synthetic aperture radar (SAR) has an unique role to play in the mapping and monitoring of large areas affected by natural disasters, especially floods, owing to its unique capability to see through clouds as well as all-weather imaging capability. DMSAR is presently mounted on-board Beechcraft B-200 aircraft and will he subsequently carried on a jet class aircraft and utilized for estimating the extent of damage over large areas (~50-75 Km) and also assess the effectiveness of the relief measures undertaken during disasters like floods. Considering the unique application requirements of disaster management, one of the major essential and critical requirements is the generation and availability of DMSAR images in real- or near-real-time with very fast turn-around times. DMSAR image generation involves complex signal processing of the acquired raw data, involving data decompression, two-dimensional SAR processing, motion sensing and compensation tasks, and image mosaicing on display as well as storage of processed SAR images on suitable recording media. [J1729]

"An Omega-K Algorithm With Phase Error Compensation for Bistatic SAR of a Translational Invariant Case"

This paper first shows the 3D property of bistatic synthetic aperture radar (BiSAR) geometry, which clarifies that the algorithms for bistatic SAR should be deduced in 3D space. It then models the bistatic echo according to the 3D geometry and obtains the signal spectrum in the wavenumber domain. Based on the spectrum, the formula for the wavenumber-domain interpolation of the omega-K algorithm is deduced, and the residual phase is obtained. Then, the impacts of the residual phase, including position displacement, range, and azimuth defocusing, and a constant phase for each pixel, are explicated. Finally, the simulating results exhibited at the end of this paper validate the correctness of the analysis and the feasibility of the algorithm. [J1730]

"Squint Spotlight SAR Raw Signal Simulation in the Frequency Domain Using Optical Principles"

Synthetic aperture radar (SAR) distributed target scene raw signal simulation is an important tool for the study and test of SAR systems and processing algorithms, mission planning, and inversion algorithm design. In this paper, the squint spotlight SAR scene model is evaluated to achieve spotlight SAR raw signals in the 2-D frequency domain and the precision of the model is analyzed. It is known that the range migration phenomenon in the time domain is explained as the coupling between the range and azimuth in the 2-D frequency domain. To realize the coupling relation in the 2-D frequency, interpolation may be needed. However, interpolation is a time-consuming manipulation. For efficiency, some signal processing methods are employed to couple the range and azimuth frequencies. Those tricks are derived from some optical principles, which give us some novel thoughts. Therefore, the efficiency of the simulator is highly improved, which facilitates its application to the verification and test of the real-time processor. [J1731]

"Distance estimation at 60 GHz band"

An FM-CW radar front-end was fabricated in an integrated manner at 60 GHz by using the NRD guide. Main emphasis was placed on compactness in size and high-precise operation in performance. The fabricated radar consists of an FM Gunn oscillator, a balanced mixer, and a planar antenna fed by leaky NRD guide with a

mechanically beam-scanning performance. All circuit components and the antenna were contained in a compact housing of 170 times 140 mm in area and 25 mm in thickness, and thus, a thin type of millimeter-wave radar front-end was successfully developed. Moreover, an error of distance estimation was measured to be less than 0.7 m. [J1732]

"ISRO's programmable digital waveform generator"

One of the major and common requirements for all active microware sensors is generation of the transmit modulation signal-like chirp/LFM signal, MSK, etc., which can be generated by analog or digital means. With the increasing demands of side bandwidth, longer duration chirp signals in radar systems, digital signal generation, and processing has emerged as a preferred alternative. Design and development of programmable and generic digital waveform generator (DWG) system based on Xilinx Virtex XCV600 FPGA and high-speed DAC is carried out at the Space Applications Center. ISRO is to generate required transmit chirp signal of high time-bandwidth product (~ 1000) for ISO's microwave radar sensor missions. This gives a detailed description of the design requirements, implementation details, salient performance features, and test results of this programmable and generic digital waveform generator (DWG). [J1733]

"Rad Lab, Luie Alvarez, and the development of the GCA Radar Landing System: A Memoir"

MIT Radiation Laboratory-or Rad Lab-was the center of microwave radar development in the US during World War II. Rad Lab designed essentially all of the microwave radars used in that war. Additionally, it created the fundamental knowledge, theory, circuits, and components used in those systems. GCA (ground control of approach, radar system for landing aircraft at night and in bad weather) was one of several programs in Division 7-all creations/inventions of Professor Luis Alvarez in the lab. The author has explained his experience in the Rad lab on developing the project with his colleagues and boss. [J1734]

"Along-track interferometry for ground moving target indication"

Synthetic aperture radar (SAR) along-track interferometry (ATI) has been used extensively to measure ocean surface currents. Given its ability to measure small velocities (-10 cm/s) of relatively radar-dark water surfaces, there is great potential that this technique can be adapted for ground moving target indication (GMTI) applications, particularly as a method for detecting very slow targets with small radar cross-sections. Herein, we describe preliminary results from an ATI GMTI experiment. The SAR data described were collected by the dual-frequency NASA/JPL airborne radar in its standard dual-baseline ATI mode. The radar system imaged a variety of control targets including a pickup truck, sport utility vehicles, passenger cars, a bicycle, and pedestrians over multiple flight passes. The control targets had horizontal velocities of less than 5 m/s. The cross-sections of the targets were not purposely enhanced, although the targets' reflectivities may have been affected by the existence of the GPS equipment used to record the targets' positions. Single-look and multiple-look interferograms processed to the full azimuth resolution were analyzed. In the data processed to date, all of the targets were observed by visual inspection in at least one of the four combinations of dual-frequency, dual-baseline interferometric data. This extremely promising result demonstrates the potential of ATI for GMTI applications. [J1735]

"Performance measure for Markovian switching systems using best-fitting Gaussian distributions"

This paper considers the theoretical posterior Cramer-Rao lower bound (PCRLB) for the case of tracking a manoeuvring target with Markovian switching dynamics. In a recent article [2] it was proposed to calculate the PCRLB conditional on the manoeuvre sequence and then determine the bound as a weighted average, giving an unconditional PCRLB. However, we demonstrate that this approach can produce an overly optimistic lower bound, because the sequence of manoeuvres is implicitly assumed known. Motivated by this, we develop a general approach and derive a closed-form estimate of the PCRLB in the case of Markovian switching systems. The basis of the approach is to, at each time step, replace the multi-modal prior target probability density function (pdf) with a best-fitting Gaussian (BFG) approximation. We present a recursive formula for calculating the mean and covariance of this Gaussian distribution, and demonstrate how the covariance increases as a result of the potential manoeuvres. We are then able to calculate the PCRLB for this BFG model using an existing Riccati-like recursion. Because of the BFG approximation, we are no longer guaranteed a bound and so we refer to our estimate as an "error performance measure" rather than a bound. The presented approach is applied both to filtering and smoothing cases. The simulation results indicate a very close agreement between the proposed performance measure and the error performance of an interacting multiple model estimator. [J1736]

"Jitter at High Speed (review of "Jitter, Noise, and Signal Integrity at High-Speed" by Mike Peng Li) [JBook Reviews]"

This book is an outgrowth of the work its author has done in the past 15 years in the areas of jitter and jitter analysis. It covers the basics of random processes and jitter and builds on these up to systems and testing. While the book places an emphasis on basic probability theory and the mathematics of jitter, there are no problems to aid this book as a text. Despite some flaws with reference and topic coverage, the book largely succeeds at providing one source for jitter information and serves as useful reference. [J1737]

"Radar Revisited (review of "Radar Handbook, 3rd ed." by Merrill Skolnik) [JBook Reviews]"

This is the third edition of an established handbook, edited by one of the most-recognized names in the field of radar technology. The volume is a compilation of 26 chapters, authored by individuals with a thorough command of, and incredible credentials in, the topics of their chapters. Most chapters have a large number of figures (up to several dozen) and extensive bibliographies. Chapters range from fairly quantitative and mathematical ones to cursory and descriptive ones. Some sections of the handbook represent a concise and readable summary of the state-of-the-art of knowledge on their topics; others are a sketchy collection of remarks for which it is difficult to identify the benefits to be derived by the reader. There is little coordination between chapters where similar topics may be discussed, and a lack of any cross-referencing. There are also weaknesses in the index, as well. While the older, classical radar topics receive much attention, the book overlooks newer areas such as coverage of automotive radars. This volume will appeal to the generalists with interest in the conventional radar subjects, and to others as a starting point for locating sources with more detailed information. [J1738]

"GLRT subspace detection for range and Doppler distributed targets"

A generalized likelihood ratio test (GLRT) is derived for adaptive detection of range and Doppler-distributed targets. The clutter is modeled as a spherically invariant random process (SIRP) and its texture component is range dependent (heterogeneous clutter). We suppose here that the speckle component covariance matrix is known or estimated thanks to a secondary data set. Thus, unknown parameters to be estimated are local texture values, the complex amplitudes and Doppler frequencies of all scattering centers. To do so, we use superresolution methods. The proposed detector assumes a priori knowledge on the spatial distribution of the target and has the precious property of having a constant false alarm rate (CFAR) with the assumption of a known speckle covariance matrix or by the use of frequency agility. [J1739]

"Signature search time evaluation in flat file databases"

For the first time, divisible load scheduling theory is used to solve for the expected time for searching for both single and multiple signatures in certain multiple processor database architectures. The target architectures examined for illustrative purposes are linear daisy chains and single level tree networks with single and multiple installment load distribution. The use of divisible load modeling and analysis yields elegant expressions for expected search time. [J1740]

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