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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 30-1

“Radar Principles”
(«Принципы радиолокации»)

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"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. [J1]

"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. [J2]

"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. [J3]

"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. [J4]

"Adaptive subspace detector for multi-input multi-output radar in the presence of steering vector mismatch"

This study studies the problem of adaptive target detection by multi-input multi-output (MIMO) radar with multiple antennas at each of the receiver sites. MIMO radar has been postulated to have a number of advantages over its monostatic counterpart. However, many previous publications have not necessarily made valid assumptions in assessing performance potential. Here, the authors consider the issue of the overall MIMO radar system steering vector which should be aligned with the desired pointing direction. However, misalignment can occur because of calibration errors, receiver channel imperfections and beam pointing errors. To account for this misalignment, the steering vector is assumed to belong to a known linear subspace. At the design stage, the authors resort to a generalised likelihood ratio principle and Rao test criterion. Subsequently, MIMO versions of the subspace generalised likelihood ratio test (MIMO-SGLRT), the subspace adaptive beam-former orthogonal rejection test (MIMO-SABORT) and the subspace Rao (MIMO-SRao) detector are developed to improve the robustness of MIMO radar detection performance for the case of steering vector mismatch. The constant false alarm rate properties of the three detectors are demonstrated. Finally, the performance of the MIMO-SGLRT, MIMO-SABORT and MIMO-SRao detectors in both the matched and mismatched steering vector cases are numerically evaluated. The results show the robustness of the proposed detectors to steering vector mismatch. [J5]

"Wavelength Coded Optical Time-Domain Reflectometry"

This paper presents a wavelength coded optical time-domain reflectometry based on optical heterodyne technique. In this scheme, the probe and reference optical pulses have different wavelengths. This enables optical heterodyne detection to be used to improve the system performances significantly. We demonstrate a spatial resolution of 2.5 m within a range of 60 km in weak-reflection signal detection and direct observation of Brillouin scattering over a long optical fiber, suggesting online fiber sensing possible. The principle of wavelength coding is applicable to other systems like lidar and radar to increase receiver sensitivity and simplify system structure. [J6]

"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. [J7]

"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. [J8]

"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. [J9]

"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. [J10]

"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. [J11]

"On the knowledge of radar coverage at sea using real time refractivity from clutter"

The principle of `refractivity from clutter` (RFC) is to invert the radar sea clutter data to retrieve the refractive index conditions in the low troposphere. This method enables to foresee radar coverage especially in the presence of abnormal refractive conditions. First, this study introduces a new formulation of the radar equation and clarifies the physical hypotheses applied in RFC. This formulation takes into account the sea clutter variations because of the grazing angle variations at very low angle and the refraction effects in one single term. This work also focuses on the analysis of results obtained using the real time `improved best fit` (IBF) inversion method for RFC. The latter is summarised and discussed with main attention on the reliability of the inverted data and on their relevancy with respect to the prediction of radar coverage. [J12]

"Interferometric Synthetic Aperture Radar (SAR) Missions Employing Formation Flying"

This paper presents an overview of single-pass interferometric Synthetic Aperture Radar (SAR) missions employing two or more satellites flying in a close formation. The simultaneous reception of the scattered radar echoes from different viewing directions by multiple spatially distributed antennas enables the acquisition of unique Earth observation products for environmental and climate monitoring. After a short introduction to the basic principles and applications of SAR interferometry, designs for the twin satellite missions TanDEM-X and Tandem-L are presented. The primary objective of TanDEM-X (TerraSAR-X add-on for Digital Elevation Measurement) is the generation of a global Digital Elevation Model (DEM) with unprecedented accuracy as the basis for a wide range of scientific research as well as for commercial DEM production. This goal is achieved by enhancing the TerraSAR-X mission with a second TerraSAR-X like satellite that will be launched in spring 2010.

Both satellites act then as a large single-pass SAR interferometer with the opportunity for flexible baseline selection. Building upon the experience gathered with the TanDEM-X mission design, the fully polarimetric L-band twin satellite formation Tandem-L is proposed. Important objectives of this highly capable interferometric SAR mission are the global acquisition of three-dimensional forest structure and biomass inventories, large-scale measurements of millimetric displacements due to tectonic shifts, and systematic observations of glacier movements. The sophisticated mission concept and the high data-acquisition capacity of Tandem-L will moreover provide a unique data source to systematically observe, analyze, and quantify the dynamics of a wide range of additional processes in the bio-, litho-, hydro-, and cryosphere. By this, Tandem-L will be an essential step to advance our understanding of the Earth system and its intricate dynamics. Enabling technologies and techniques are described in detail. An ou--tlook on future interferometric and tomographic concepts and developments, including multistatic SAR systems with multiple receivers, is provided. [J13]

"Electromagnetic Scattering From an Arbitrarily Shaped Bi-Isotropic Body of Revolution"

Electromagnetic scattering is investigated for an arbitrarily shaped bi-isotropic body of revolution. The surface equivalent principle is applied to represent the electromagnetic fields inside bi-isotropic material in term of equivalent surface electric and magnetic currents, and a field decomposition method is introduced to simplify the handling of these equivalent surface currents. By enforcing boundary condition, a set of coupled surface integral equations is established. Incorporated by Galerkin procedure, Method of Moment is used to solve this set of equations. To utilize the rotational symmetry of body of revolution, the equivalent surface currents are expanded in term of Fourier series, and then expanded in terms of triangular basic function. The solution is implemented with a computer program written in Fortran language. To validate this solution, bistatic radar cross section of scattering by two different bi-isotropic scatters are presented, and good agreement is found. [J14]

"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. [J15]

"Analysis and Design of Ultra Thin Electromagnetic Absorbers Comprising Resistively Loaded High Impedance Surfaces"

High-impedance surfaces (HIS) comprising lossy frequency selective surfaces (FSS) are employed to design thin electromagnetic absorbers. The structure, despite its typical resonant behavior, is able to perform a very wideband absorption in a reduced thickness. Losses in the frequency selective surface are introduced by printing the periodic pattern through resistive inks and hence avoiding the typical soldering of a large number of lumped resistors. The effect of the surface resistance of the FSS and dielectric substrate characteristics on the input impedance of the absorber is discussed by means of a circuital model. It is shown that the optimum value of surface resistance is affected both by substrate parameters (thickness and permittivity) and by FSS element shape. The equivalent circuit model is then used to introduce the working principles of the narrowband and the wideband absorbing structure and to derive the best-suited element for wideband absorption. [J16]

"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. [J17]

"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. [J18]

"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. [J19]

"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. [J20]

"Remote Survey of the Leaning Tower of Pisa by Interferometric Sensing"

The Leaning Tower of Pisa, one of the world-famous architectural marvels of Italian heritage, needs continuous surveying to assess its stability. In this letter, remote-sensing equipment recently developed by the authors, based on the principle of microwave radar interferometry, has been experimented to measure the frequency response of the Tower without requiring any contact with its structure. Wind and human traffic were used as natural excitation sources, allowing the natural frequencies of the first vibration mode of the Tower to be measured in the north-south and in the west-east directions. Modal shapes of the Tower vibrations were also obtained from data acquired by the radar. [J21]

"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. [J22]

"Study of a Uniplanar Monopole Antenna for Passive Chipless UWB-RFID Localization System"

The principle of a passive chipless ultrawideband-enabled radio-frequency identification (UWB-RFID) and localization system is firstly introduced. A uniplanar monopole antenna with a size of only 23 ?? 23 ?? 0.508 mm is then designed. Six passive chipless tags based on the antenna structure are subsequently developed for the system application. The backscattering characteristics of the tags are theoretically and experimentally studied in both the frequency and time domain. Following that, a simple receiver structure is proposed to simultaneously identify these tags and find their ranges. Results show that the proposed tags are excellent candidates for passive chipless UWB-RFID localization system applications. [J23]

"A Comparison of a Wide-Slot and a Stacked Patch Antenna for the Purpose of Breast Cancer Detection"

A wide-slot UWB antenna is presented for intended use in the detection scheme being developed at the University of Bristol, based on the principle of synthetically focused UWB radar using a fully populated static array. The antenna's measured and simulated, input and radiation characteristics are presented and compared to an existing, stacked patch antenna that has been designed for the same purpose. The results of this study show that the wide-slot antenna has excellent performance across the required frequency range. Compared to the stacked-patch antenna used in our previous array, the wide-slot antenna can be 3 times smaller (in terms of front surface). The compact nature of the slot antenna means that the detection array can be densely populated. Additionally, this new antenna offers better radiation coverage of the breast. For angles up to 60?? away from bore-sight radiated pulses are almost identical (fidelity >95%), whereas for the patch antenna fidelity falls to 58% at the angular extremes. This uniform radiation into the breast should result in focused images with low levels of clutter. [J24]

"Acceleration of Ray-Based Radar Cross Section Predictions Using Monostatic-Bistatic Equivalence"

An approach is presented to simulate the monostatic scattering properties of complex shaped realistic objects in a very efficient way. To achieve this, the calculation of the radar cross section (RCS) in the high frequency regime based on the well known shooting and bouncing rays (SBR) technique is considerably accelerated by the use of the monostatic bistatic equivalence principle. Instead of performing independent simulations for all required aspect angles, the concept is based on the idea of additionally exploiting bistatic information for some neighboring aspect angles. This information is obtained relatively cheaply during the SBR process and it can be favorably exploited under certain conditions, mainly that the bistatic angle is small and the object is sufficiently smooth. In this case, the results of the geometrical ray tracing, which consumes a large part of the computational resources for complex shaped objects is reused multiple times with only low additional computational resources. The basic principles and benefits of the methodology are discussed as well as its limitations and drawbacks. Different generic simulation examples are used to show the general applicability of the method and to examine the degradation of the results depending on the applied bistatic angle. Based on these experiences, a passenger car model is simulated at 10 GHz and a considerable reduction of the computational effort by a factor of 32 is estimated for the complete multiaspect simulation problem. [J25]

"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. [J26]

"One-Dimensional Mirrored Interferometric Aperture Synthesis"

Aperture synthesis technique can provide high spatial resolution without requiring very large and massive real

aperture. However, for a large aperture synthesis system, which will involve hundreds of antennas and thousands of correlators, system and its calibration are very complicated. In this letter, mirrored interferometric aperture synthesis (MIAS) is proposed, which can achieve the same spatial resolution as a large traditional aperture synthesis system but needs fewer antennas. First, the imaging principle of MIAS is presented. A new concept, named Cosine Visibility, is proposed to replace the visibility function used in traditional aperture synthesis. The relationship between the brightness temperature and the cosine visibility is a Cosine Transform. Inverse Cosine Transform can be applied to reconstruct the image of brightness temperature. Then, an example for MIAS is given, and a method is proposed to handle the problems of baselines missing and the rank defect associated with the underdetermined linear equations which relate the cross correlation between signals collected by pairs of antennas with the cosine visibility. Moreover, MIAS with a small array can provide higher and higher spatial resolution by combining more and more linear equations with the help of adjusting the distance from the array to the reflector. The simulation results demonstrate the validity of MIAS and the improvement of spatial resolution. The study in this letter provides a means to reduce the complexity of system and calibration of large traditional aperture synthesis systems. [J27]

"Fast Learning of Grammar Production Probabilities in Radar Electronic Support"

Although stochastic context-free grammars (SCFG) appear promising for the recognition and threat assessment of complex radar emitters in radar electronic support (ES) systems, the computational requirements for learning their production rule probabilities can be onerous. The two most popular methods, the inside-outside (IO) algorithm and the Viterbi score (VS) algorithm, are both iterative. IO maximizes the likelihood of a training data set, whereas VS maximizes the likelihood of its best parse trees. Even though VS is known to have lower overall computational costs in practice, both algorithms can be impractical for complex grammatical models. Several techniques have been previously developed to accelerate learning. In this paper, two fast variants of the traditional IO algorithm, known as graphical expectation-maximization (gEM(IO)) and tree-scanning (TS(IO)), are reviewed, along with a third technique called HOLA. In addition, two novel algorithms are proposed that apply the gEM (gEM(VS)) and TS (TS(VS)) principles to the Viterbi technique. An experimental protocol is defined and implemented so that the performance of all five techniques (gEM(IO), TS(IO), gEM(VS), TS(VS), and HOLA) can be compared using simulated training sets of complex radar signals. These techniques are compared from several perspectives—perplexity (the likelihood of a test data set), error rate on estimated states, time and memory complexity per iteration, and convergence time. Estimation of the average case and worst case execution time and storage requirements allow for the assessment of complexity, while computer simulations, performed using radar data sets, allow for the assessment of the other performance measures. The impact on performance of the number of sequences in the training set is observed. Results indicate that gEM(IO) and TS(IO) provide the same level of accuracy, yet the resources requirements depend on the ambiguity of the grammars. As expected, the gEM(VS) and TS(VS)-- techniques provide significantly lower convergence times and time complexities in practice than gEM(IO) and TS(IO), for a comparable level of accuracy. All of these algorithms may provide a greater level of accuracy than HOLA, yet their computational complexities may be orders of magnitude higher. [J28]

"Simulations on the Role of the Resonance of the Probing Wave on Reflectometry Measurements in Fluctuating Plasmas"

In fusion plasmas for energy, turbulence is clearly associated to the anomalous transport of energy and particles. Diagnostics using electromagnetic waves is usually used to measure the plasma parameters and the turbulence characteristics. One of the diagnostics is reflectometry, which is based on the radar principle and can be used to reach these different goals: density profile, turbulence characterization, plasma positioning, etc. During the plasma probing, fast phase variations called phase jumps have been measured, and part of them can be explained by a local enhancement of the probing field. Using an analytical model to compute the probing electric field amplification, a new expression for the phase variations has been written, taking into account the amplification of the probing electric field. This formula exhibits a good agreement with the full-wave computations. A possible improvement of the reflectometer sensitivity can be done using the local enhancement of the probing electric field induced by Bragg resonant density perturbations, which build resonant cavities. The computed cases show that it is possible to improve the reflectometry measurements when the local enhancement of the probing electric field exists. To illustrate the possible improvements, simulations of the radial wavenumber spectrum reconstruction have been done, and they confirm the possibility to increase the sensitivity and the spatial resolution for a given range of wavenumber. [J29]

"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. [J30]

"Terahertz Imaging Systems With Aperture Synthesis Techniques"

This paper presents the research and development of two terahertz imaging systems based on photonic and electronic principles, respectively. As part of this study, a survey of ongoing research in the field of terahertz imaging is provided focusing on security applications. Existing terahertz imaging systems are reviewed in terms of the employed architecture and data processing strategies. Active multichannel measurement method is found to be promising for real-time applications among the various terahertz imaging techniques and is chosen as a basis for the imaging instruments presented in this paper. An active system operation allows for a wide dynamic range, which is important for image quality. The described instruments employ a multichannel high-sensitivity heterodyne architecture and aperture filling techniques, with close to real-time image acquisition time. In the case of the photonic imaging system, mechanical scanning is completely obsolete. We show 2-D images of simulated 3-D image data for both systems. The reconstruction algorithms are suitable for 3-D real-time operation, only limited by mechanical scanning. [J31]

"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. [J32]

"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. [J33]

"Low-Profile Multifrequency HF Antenna Design for Coastal Radar Applications"

A novel design for an electrically small high-frequency (HF) antenna suitable for coastal radar applications is presented. The principle design objectives were to develop an HF antenna resonant at multiple frequencies that is also compact and easily transportable for deployment to coastal sites and on floating platforms. The compact antenna achieves practical performance values for radiation resistance, bandwidth, and gain while maintaining small values of ka. The design presented in this letter consists of a meandering line antenna composed of helical elements and switchable folded arms. The value of ka ranges down to 0.16 at 5.7 MHz. The antenna is self-resonant at multiple frequencies including 5.7, 16.1, 20.6, and 28.1 MHz for open-circuit mode and 15.1, 18.5, and 26.1 for the short-circuit mode. In all cases, input impedances were easily matched to 50-Ω coaxial feed lines, and the achieved bandwidths ranged from 1% to 12% within the HF band (3-30 MHz). The antenna is 90 cm high with a small ground disk of 60 cm diameter. Simulation results and prototype experimental measurements are presented. [J34]

"L-band array for ground-based remote sensing of volcanic eruptions"

In this study, an L-band array for ground-based remote sensing of volcanic eruptions will be presented. The proposed array configuration was created using a particular class of microstrip elements, namely shorted rectangular patch (SRP) antennas, with improved directivity arranged in a 6Ч6 array with high inter-element spacing. This solution allowed high directivity, while grating lobe effects were mitigated by the element factor. The array was developed for use with volcano Doppler radar (Voldorad), a volcanological Doppler radar used to remotely sense summit eruptions of Mt. Etna in Sicily, where the prototype Voldorad is now located. The main features of the SRP and the design principles of the array will be presented, along with simulated and measured results. [J35]

"Multiband electromagnetic wave absorber based on reactive impedance ground planes"

A novel structure able to perform multi-band absorption is presented. As is well known, the most famous and simplest radar absorbing material is the Salisbury screen. Improved solutions, aimed at a thickness reduction, have been presented in the literature, conceptually based on metamaterials and employing properly designed high-impedance surfaces (HIS) in practice. The absorber presented here combines the working principles of the previously mentioned designs in order to join the two types of absorber into a single structure. The novel design comprises a single resistive sheet mounted at a fixed distance from a reactive surface. The latter is a composite layer of a frequency selective surface printed on a grounded dielectric slab acting as an artificial magnetic conductor at lower frequencies, while responding as a perfect electric conductor at higher frequencies. The distance of the resistive sheet can therefore be dimensioned so as to recover the Salisbury functions in the upper band, while operating as a λ/10 absorber in the low-frequency regime. The structure is explained by means of a simple circuital model and measured data are reported to verify the proposed concepts. It is finally shown that low-frequency resonance can be advantageously adjusted by introducing some active elements in the HIS. [J36]

"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. [J37]

"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. [J38]

"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. [J39]

"A Generalized Synthesis Procedure for Low-Profile, Frequency Selective Surfaces With Odd-Order Bandpass Responses"

We present a generalized synthesis procedure for designing low-profile frequency selective surfaces (FSS) with bandpass responses of odd-order (N = 3,5,7,...). The FSSs designed using this technique use a combination of resonant and non-resonant sub-wavelength constituting unit cells with unit cell dimensions and periodicities in the order of 0.15 λ0, where λ0is the free space wavelength. The main advantage of using this technique, compared to traditional FSS design techniques, is that it allows for the design of low-profile and ultrathin FSSs that can provide sharp frequency selectivity. An Nth order FSS designed using this technique typically has an

electrical thickness in the order of ~ (N-1) λ0/50 which is significantly smaller than the overall thickness of a traditionally designed Nth order FSS (~ (N-1) λ0/4). The proposed synthesis procedure is validated for two FSS prototypes having third- and fifth-order bandpass responses. Principles of operation, detailed synthesis procedure, and implementation guidelines for this type of FSS are presented and discussed in this communication. [J40]

"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. [J41]

"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. [J42]

"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. [J43]

"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. [J44]

"UWB CMOS Monocycle Pulse Generator"

A low-complexity fully integrated ultrawideband (UWB) monocycle pulse generator realized in 90-nm CMOS technology by ST-Microelectronics is presented. The circuit provides a monocycle pulse when activated by a negative edge of an external trigger signal provided by a microcontroller by exploiting the operating principle of nonlinear waveform shapers. This pulse generator represents a building block of an innovative wearable system-on-chip UWB radar on silicon for cardiopulmonary monitoring. On-chip measurements show that the pulse generator provides monocycle pulses with a duration time equal to 380 ps and a peak-to-peak amplitude of 660 mV (including the losses of the microprobes, cables, and electrostatic-discharge-protected pads), which are in very good agreement with the postlayout simulations. The power consumption is 19.8 mW from a 1.2-V power supply. [J45]

"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. [J46]

"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. [J47]

"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. [J48]

"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. [J49]

"Basic Properties and Design Principles of UWB Antennas"

Basic principles for ultra-wide-band (UWB) radiation are presented and discussed in this paper. The discussion starts with a description of the influence of antennas on UWB transmission. The parameters characterizing antennas in time and in frequency domain are specified. Since the number of possible antenna structures is nearly unlimited, the focus will be on a classification according to different radiation principles. For each of these mechanisms, the typical advantages and disadvantages are discussed, and an example antenna and its characteristics are presented. For a wireless engineer, the problem to solve is the proper design of an antenna with the desired radiation characteristics. The final outcome of this paper is that there exist numbers of UWB antennas, but not each of them is suited for any application, especially in view of radar and communication systems requirements. [J50]

"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. [J51]

"A New Technique for Design of Low-Profile, Second-Order, Bandpass Frequency Selective Surfaces"

In this study, a new method for designing low profile frequency selective surfaces (FSS) with second-order bandpass responses is presented. The FSSs designed using this technique utilize non-resonant subwavelength constituting unit cells with unit cell dimensions and periodicities in the order of 0.15lambda0. It is demonstrated that using the proposed technique, second-order FSSs with an overall thickness of lambda0/30 can be designed. This is considerably smaller than the thickness of second-order FSSs designed using traditional techniques and could be particularly useful at lower frequencies with long wavelengths. To facilitate the design of this structure, an equivalent circuit based synthesis method is also presented in this paper. Two bandpass FSS prototypes operating at X-band are designed, fabricated, and tested. A free space measurement setup is used to thoroughly characterize the frequency responses of these prototypes for both the TE and TM polarizations and various angles of incidence. The frequency responses of these structures are shown to have a relatively low sensitivity to the angle of incidence. Principles of operation, detailed design and synthesis procedure, and measurement results of two fabricated prototypes are presented and discussed in this paper. [J52]

"Standoff 3D Gamma-Ray Imaging"

We present a new standoff imaging technique able to provide 3-dimensional (3D) images of gamma-ray sources distributed in the environment. Unlike standard 3D tomographic methods, this technique does not require the radioactive sources to be bounded within a predefined physical space. In the present implementation, the gamma-ray imaging system is based on two large planar HPGe double sided segmented detectors, which are used in a Compton camera configuration. A LIDAR system is used in conjunction with the gamma-ray imaging system to confine the gamma-ray image space to the interior of physical objects situated within the detection range of the gamma-ray imager. This approach results in superior image contrast and efficient image reconstruction. Results demonstrating the operating principle are reported. [J53]

"A Narrow-Linewidth, Yb Fiber-Amplifier-Based Upper Atmospheric Doppler Temperature Lidar"

A compelling use for high-power, narrow-linewidth fiber lasers and amplifiers is atmospheric Doppler lidars. Such systems require high power, good beam quality, a broad tuning range, and ruggedness. In this paper, we present a ground-based diode-seeded, high-power, narrow-linewidth Yb fiber-amplifier-based Doppler temperature lidar operating at 1083 nm for measuring temperature and density of the neutral atmosphere from 300 to 1000 km. Principles of Doppler resonance fluorescence lidar will be introduced. The current state of the fiber-based lidar system will be addressed, as well as ongoing work to increase SNR through power scaling and improvement of spatial resolution and wind measurement capability via pulsed operation. [J54]

"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. [J55]

"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. [J56]

"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. [J57]

"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. [J58]

"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. [J59]

"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". [J60]

"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. [J61]

"DEM Error Retrieval by Analyzing Time Series of Differential Interferograms"

Two-pass differential synthetic aperture radar interferometry processing have been successfully used by the scientific community to derive velocity fields. Nevertheless, a precise digital elevation model (DEM) is necessary to remove the topographic component from the interferograms. This letter presents a novel method to detect and retrieve DEM errors by analyzing time series of differential interferograms. The principle of the method is based on the comparison of fringe patterns with the perpendicular baseline. First, a mathematical description of the algorithm is exposed. Then, the algorithm is applied on a series of four one-day European Remote Sensing 1 and 2 satellite (ERS-1/2) interferograms. [J62]

"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. [J63]

"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. [J64]

"Application of Bionics in Antenna Radar Cross Section Reduction"

Bionics principle is applied to antenna radar cross section (RCS) reduction in this letter for the first time. To authenticate the method, a novel bionic ultrawideband (UWB) antenna is proposed by use of a model of insect tentacle. Its UWB-related radiation characteristics are simulated and experimentally verified. Monostatic RCS of an insect tentacle antenna (ITA) terminated with three different loads are studied and compared with that of a common printed circular-disc monopole antenna (PCDMA). The results show that compared to the reference antenna, the novel bionic antenna has lower RCS and favorable radiation performances. Hence, applying bionics principle to antenna RCS reduction is feasible, which will serve as a good candidate for the future design of antennas with a requirement of RCS control. [J65]

"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%. [J66]

"Dual-Orthogonal Polarized Antenna for UWB-IR Technology"

This letter presents a design of a dual-orthogonal, linear polarized antenna for the UWB-IR technology in the frequency range from 3.1 to 10.6 GHz. The antenna is compact with dimensions of 40 times 40 mm of the radiation plane, which is orthogonal to the radiation direction. Both the antenna and the feeding network are realized in planar technology. The radiation principle and the computed design are verified by a prototype. The input impedance matching is better than -6 dB. The measured results show a mean gain in copolarization close to 4 dBi. The cross-polarizations suppression w.r.t. the copolarization is better than 20 dB. Due to its features, the antenna is suited for polarimetric ultrawideband (UWB) radar and UWB multiple-input-multiple-output (MIMO) applications. [J67]

"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. [J68]

"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. [J69]

"Transmission Through Layered Media With Rough Boundaries: First-Order Perturbative Solution"

We investigate analytically the fully polarimetric electromagnetic wave propagation through a 3-D layered structure. In the framework of the first-order limit of the perturbation theory, a transmission model for a layered structure with an arbitrary number of rough interfaces is developed and an elegant closed-form solution is obtained. The final expressions, in terms of generalized reflection/transmission coefficients, provide parametrically a direct characterization of the scattering properties of the layered structure in terms of the structure's (geometric and electromagnetic) parameters. In addition, we point out the complementary character of the obtained scattering solution with respect to the existing one. Finally, we demonstrate that our solution satisfies the reciprocity principle. [J70]

"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. [J71]

"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. [J72]

"Motion error correction of range migration algorithm for aircraft spotlight SAR imaging"

Since a motion error is the main phase error source in the aircraft synthetic aperture radar, several reconstruction algorithms with motion error correction have been developed. An efficient motion compensation via the known motion error information is proposed. Specifically, the proposed method is based on the subarea technique with shifting and the subaperture technique via the mean values of the motion errors. Then, using the extended Taylor approximation and the principle of the stationary phase, the motion errors are corrected through compensation at the mixing stage and the Stolt interpolation stage. [J73]

"A New Adaptive Multiresolution Noise-Filtering Approach for SAR Interferometric Phase Images"

This letter presents a novel adaptive multiresolution technique to estimate the local fringe frequency in synthetic aperture radar (SAR) interferometric phase images. According to the coherent summation principle, the size and the shape of the interferogram spatial resolution for local frequency estimation are adapted pixel by pixel to track the topographic changes and optimize the space-frequency resolution. We show that, comparing conventional filters with the processing window of a fixed size (such as 7 times 7) and shape (such as a square), the proposed approach avoids the loss of phase fringes and provides a more accurate representation of the scene topography. In this letter, we present a method to eliminate invalid frequency estimation. A fast frequency estimation approach modified from the method proposed by Trouve et al. is also shown. Finally, both simulated data and actual SAR data are utilized to illustrate the effectiveness of the proposed method. [J74]

"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. [J75]

"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. [J76]

"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. [J77]

"The Switched Injection-Locked Oscillator: A Novel Versatile Concept for Wireless Transponder and Localization Systems"

In this paper, the novel principle of the switched injection-locked oscillator is introduced. It is shown that the concept is ideally suited for transponder and secondary radar systems with outstanding performance. A switched injection-locked oscillator transponder can produce an approximately phase coherent high-power response to an interrogating signal and, consequently, allows for long-range transponder systems and precise distance measurement between the reader and transponder. The simple and elegant round-trip time-of-flight measurement concept introduced in this paper enables innovative localization and navigation systems. Furthermore, it can be applied in numerous areas such as sensor networks, RF identification and localization, ubiquitous computing, location sensitive billing, context dependent information services, or tracking and guiding. [J78]

"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. [J79]

"Basic Slant Range-Doppler Modeling of Moving Scatterers for SAR Applications"

A fundamental spectral domain model for moving point and distribution of scatterers is presented. The approach is accurate as the spherical phase front is rigorously treated throughout the Doppler analysis. Due to the analytic

nature of the model in the range-Doppler plain, large squint-angle operations (e.g., SpotSAR) can be characterized. Furthermore, motion characteristics can be extracted in the subaperture level to better reflect the general motion (e.g., nonuniform). The range-Doppler model can serve as a tool for polarimetric and multichannel analysis. [J80]

"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. [J81]

"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. [J82]

"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. [J83]

"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. [J84]

"Comparison of Processing Algorithms for a Delay/Doppler Altimeter"

The use of a radar altimeter is to measure the height of the reflecting surface when the instrument passes overhead. A delay/Doppler altimeter (DDA) reduces the along-track resolution cell using correlation of pulses within burst, as in a synthetic aperture radar, with the net effect of synthesizing an array with a narrower lobe. The processing of DDA data therefore implies the correction of the phase delay of pulses, which is said to be Dopplerbeamsharpeningsince it can be reduced to a DFT in the along-track direction. The noise term on Doppler echoes is decreased by incoherent summing of contributions of different bursts. Summation of these contributions

requires that pointing of each beam is directed toward a given output grid of samples on ground, and this can be a nontrivial task, depending on the topography profile. In this letter, a comparison between different beam sharpening algorithms is presented: Two of them are similar in their basic idea even if with different implementations; the third one can be considered as reference since no approximations are needed in principle, but is computationally inefficient. What results is that the first couple can be considered basically equivalent in terms of precision and computational efficiency, with little differences at the change of the environmental conditions. Results based on simulated data of simple and complex scenarios are presented as support of the reasoning. [J85]

"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. [J86]

"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. [J87]

"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%. [J88]

"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. [J89]

"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. [J90]

"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. [J91]

"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. [J92]

"Investigation of Radar Propagation in Buildings: A 10-Billion Element Cartesian-Mesh FETD Simulation"

Large-scale full-wave simulations are performed to investigate radar wave propagation inside buildings. In principle, a radar system combined with sophisticated numerical methods for inverse problems can be used to determine the internal structure of a building. The composition of the walls (cinder block, rebar) may effect the propagation of the radar waves in a complicated manner. In order to provide a benchmark solution of radar propagation in buildings, including the effects of cinder block and rebar, we performed large-scale full-wave simulations using a finite-element time domain (FETD) method. This particular FETD implementation is tuned for the special case of an orthogonal Cartesian mesh and hence resembles finite-difference time domain (FDTD) in accuracy and efficiency. The method was implemented on a general-purpose massively parallel computer. In this paper we briefly describe the radar propagation problem, the FETD implementation, and we present results of simulations that used over 10-billion elements. [J93]

"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. [J94]

"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. [J95]

"Statistical Properties of Low-Grazing Range-Resolved Sea Surface Backscatter Generated Through Two-Dimensional Direct Numerical Simulations"

Statistical properties of the X-band sea clutter are studied using 2-D direct numerical simulations. Surfaces are modeled as realizations of a Gaussian random process with the Pierson-Moskowitz or Elfouhaily spectrum. The Creamer transform is further applied to account for the lowest-order surface nonlinearities. Backscattered field at a given frequency is found using the first-principles boundary integral equation (BIE) technique. Calculations are repeated at a number of frequencies, which allows synthesizing the surface response to a pulse as short as 2.2 ns (the corresponding spatial resolution is 0.33 m). Large-scale Monte Carlo trials are used to evaluate the correlation properties and to obtain the probability distributions for the vertically- and horizontally-polarized clutter. This paper concentrates on the incident angle of 85deg (5deg grazing), with a few results for moderate 60deg incidence also reported for comparison. The effects of variations in wind speed (sea state) and radar resolution on the clutter statistics are investigated. An L-band example (with proportionally longer pulse) helps explore the role of a different electromagnetic (e/m) wavelength. The simulation technique also allows for the isolation and examination of the impacts of certain e/m and hydrodynamic approximations, including the replacement of rigorous solution to the BIE by a simpler analytical scattering model. The amplitude statistics of the simulated backscatter are compared to the Weibull and K distributions that are often used to describe surface clutter [J96]

"SAR Imaging Degradation by Ionospheric Irregularities Based on TFTPCF Analysis"

The effects of ionospheric irregularities on spaceborne synthetic aperture radar (SAR) signal propagation with double path and multilook angle are studied in a model in which a two-frequency and two-position coherence function (TFTPCF) has been adopted for analysis. The TFTPCF is derived from the phase-screen principle. The ambiguity function based on TFTPCF has been used to analyze the effects of ionospheric turbulence on range resolution and cross resolution. The results show that, in some cases, the effects from the irregularities on SAR imaging can be very serious [J97]

"Mathematics of Synthesizing Range Profile"

The mathematics of synthesizing a high-range resolution profile (HRRP) is discussed. With a generalized model of synthetic wideband signal and its echo signal, stretch processing technique is extended and refined. Then, an investigation on the mathematic principle of synthesizing a range profile demonstrates that quadratic phase error criterion does not exactly represent the effect of motion on a synthetic range profile (SRP). Therefore, a least-mean-square error criterion is proposed, and several conclusions about the new criterion are derived. In addition, specific conclusions about the distortion for a stepped-frequency waveform (SFW) are investigated with some simulations [J98]

"Adaptive CFAR Radar Detection With Conic Rejection"

In this paper, we deal with the problem of adaptive signal detection in colored Gaussian disturbance. Since the

classical receivers may exhibit severe performance degradations in the presence of steering vector mismatches and sidelobe interfering signals, we try to account for the quoted drawbacks, very usual in realistic radar scenarios, at the design stage. To this end, we first characterize the set where the useful received signal may lie and its complement, i.e., the set which may contain the signals to be rejected. Then we resort to the generalized likelihood ratio (GLR) principle and devise detectors capable of operating in the presence of array response mismatches and sidelobe interfering signals. At the analysis stage, we assess the performance of the newly introduced receivers also in comparison with previously proposed detectors. The results show that the new processors are characterized by a wide range of performance compromises, selectable at the design stage through the regulation of a design parameter, between the detection of useful signals and the rejection of sidelobe interference [J99]

"**THIS ARTICLE HAS BEEN RETRACTED DUE TO A VIOLATION OF IET PUBLICATION PRINCIPLES** Specular and diffuse measurements of multipath from various terrain surfaces at 35 GHz"

Measurements of height-gain interference patterns at 35 GHz are carried out in order to obtain multipath interference data over various types of terrain viz. grass, road surface and concrete. The antenna with a beam width of 21deg is used both at transmitting and receiving ends to ensure full illumination of Fresnel zones. The transmitting antenna height is kept at 1 m and receiving antenna height is vertically translated from 1 through 4 m, with a horizontal range separation of 74 m. The polarisation combination is vertical transmit and vertical receive. The system geometry provides low-grazing angle incidence. The recorded height-gain curves indicate the presence of specular and diffuse multipath components. Specular and diffuse multipath components are separated out using discrete fourier transform-based filtering technique and reflection coefficients are computed for various types of terrain covers. The results can be vitally useful for millimetre wave radar, guidance, remote sensing and communication systems operating near the surface in arid conditions [J100]

"A Keystone Transform Without Interpolation for SAR Ground Moving-Target Imaging"

Synthetic aperture radar (SAR) image formation for a ground moving target necessitates the compensation of the unknown target trajectory. The keystone transform has been employed to remove the linear component of the range migration for the moving target, where interpolation is required. In this letter, a realization of the keystone transform avoiding interpolation is presented. The kernel of this transform, i.e., the range-frequency-dependent azimuth time rescaling, is implemented using only complex multiplications and fast Fourier transforms based on the scaling principle, which has been successfully applied in the equalization of the space-variant range cell migration in SAR processing. In addition, the moving target is coarsely focused according to the SAR geometry and the platform velocity while exploiting the scaling principle. This preliminary focusing is helpful in the isolation of the moving target from ground clutter, so as to facilitate a more refined processing with respect to each mover. SAR raw data combined with simulated echoes of moving targets are utilized to validate the presented approach [J101]

"GO Shaping of Omnidirectional Dual-Reflector Antennas for a Prescribed Equi-Phase Aperture Field Distribution"

A formulation is presented for shaping dual-reflector antennas designed to offer an omnidirectional coverage. The shaping procedure is based on geometrical optics (GO) principles and assumes a uniform phase distribution for the aperture field. Two distinct dual-reflector arrangements, based on the axis-displaced Cassegrain (ADC) and ellipse (ADE) configurations, are investigated. The GO shaping results are validated using the accurate analysis provided by the method-of-moments technique [J102]

"A New Advance in Circular Polarization Selective Surface—A Three Layered CPSS Without Vertical Conductive Segments"

Investigations into a surface that reflects one sense of circularly polarized electromagnetic wave but transmits the other, namely a circular-polarization selective surface (CPSS), were carried out. This paper presents CPSS using simple planar structure without any vertical conductive segments. Couplings, through the use of L-shaped traces, were produced to replace the vias. Operational principle and design procedure are developed, thus the optimal design parameters are found. Also presented are the results of numerical computations and measurements for "isolation" and "transmission loss". A 30 GHz example demonstrates the performances of the design and the attractiveness in millimeter-wave circular polarization selectivity applications [J103]

"Range migration algorithm for airborne squint mode spotlight SAR imaging"

Since the reference signal based on the fixed reference range is used in the range migration algorithm (RMA), the RMA is not available to process an airborne squint-mode spotlight synthetic aperture radar (SAR) data. Thus, the modified reference signal to transform a squint-mode data to a broadside-mode data is introduced on the basis of the coordinate transformation and the extended Taylor approximation. Then, using the principle of the stationary phase, the presented formulation is analysed. Moreover, to compensate curvature errors, the proposed method is extended on the basis of the subarea technique. Finally, the effectiveness of the proposed method is demonstrated by some numerical simulations via a pulsed spotlight SAR simulator [J104]

"Gamma-Ray Backscattering Tomography Approach Based on the Lidar Principle"

An approach is proposed, and its potentialities are studied, for single-sided gamma-ray in-depth sensing and tomography of dense opaque media. The approach is based on lidar (LIgth Detection And Ranging) principle or, in the present case, graydar (Gamma RAY Detection And Ranging) principle, that is, time-to-range resolved detection of the backscattering-due radiative returns from the probed object irradiated by pulsed gamma-photon pencil beams. The basic analysis and data processing delta-pulse single-scattering graydar equation is formulated by analogy with the lidar equation and is shown to be applicable, under some determinate conditions, to the problems of gamma-ray in-depth profiling of dense media. It is shown analytically and by computer simulations that the approach developed in the work would enable one, at large-enough but reasonable sensing photon fluxes and measurement time intervals, to determine with good controllable accuracy and resolution the location, the material content, and the mass density of different homogeneous ingredients inside the probed object as well as the mass (or electron) density distribution within one-material objects. This approach can be widely applied, e.g., for nondestructive material examination in industry and aviation, detection of landmines and explosives, investigating the constitution of archeological artifacts, etc [J105]

"Vehicle Classification Based on the Radar Measurement of Height Profiles"

The problem of classifying road vehicles according to vehicle type is considered. The proposed solution is based on using vehicle height and length and height profiles obtained by a microwave (MW) radar sensor. We show that if the radar sensor satisfies certain requirements, then a precise feature vector can be extracted, and simple deterministic algorithms can be applied to determine the vehicle class. Field trials using a spread-spectrum MW radar sensor system operating on these principles have been carried out. They confirm that accurate classification of a large number of vehicle classes can be reached [J106]

"Design Principles of MIMO Radar Detectors"

This paper considers the problem of multiple-input multiple-output (MIMO) radars employing space-time coding (STC) to achieve diversity. To this end, after briefly outlining the model of the received echo, a suitable detection structure is derived, and its performance is expressed in closed form as a function of the clutter statistical properties and of the space-time code matrix. Interestingly, this receiver requires prior knowledge of the clutter covariance, but the detection threshold is functionally independent thereof. At the transmitter design stage, we give two criteria for code construction: the first is based on the classical Chernoff bound, the second is an information-theoretic criterion. Interestingly, the two criteria lead to the same condition for code optimality, which in turn specializes, under the assumption of uncorrelated clutter and square code matrix, in some well-known full-rate space-time codes. A thorough performance assessment is also given, so as to establish the optimum achievable performance for MIMO radar systems. [J107]

"Monitoring system for thermal barrier coatings with RF radar measurement"

A monitoring principle able to identify damage on the thermal barrier coating of gas turbine blades and vanes is presented. The principle is applicable to in-service turbine monitoring. It is based on the resonant quarter wavelength effect of thin layers, which causes phase shift and attenuation of the reflected signal. The reflectivity is derived theoretically and evaluated by laboratory measurements. It was evident that especially the phase information is adequate to distinguish coated areas from those where coating has already been spalled off. [J108]

"Inverse Synthetic Aperture Secondary Radar Concept for Precise Wireless Positioning"

In this paper, the novel inverse synthetic aperture secondary radar wireless positioning technique is introduced. The proposed concept allows for a precise spatial localization of a backscatter transponder even in dense multipath environments. A novel secondary radar signal evaluation concept compensates for the unknown modulation phase of the returned signal and thus leads to radar signals comparable to common primary radar. With use of this concept, inverse synthetic aperture radar algorithms can be applied to the signals of backscatter transponder systems. In simulations and first experiments, we used a broadband holographic reconstruction

principle to realize the inverse synthetic aperture approach. The movement of the transponder along a short arbitrary aperture path is determined with assisting relative sensors (dead reckoning or inertia sensors). A set of signals measured along the aperture is adaptively focused to the transponder position. By this focusing technique, multipath reflections can be suppressed impressively and a precise indoor positioning becomes feasible. With our technique, completely new and powerful options for integrated navigation and sensor fusion in RF identification systems and wireless local positioning systems are now possible. [J109]

"Polarimetric Analysis of Bistatic SAR Images From Polar Decomposition: A Quaternion Approach"

This paper focuses on polar decomposition, which is based on the quaternion formalism, in single-look and multilook synthetic aperture radar polarimetry. Polar decomposition is used to decompose a bistatic or monostatic polarimetric scattering matrix into a product of a Hermitian matrix (boost) and a unitary matrix (rotation). After an overview of polar decomposition principle and quaternion properties, coherent (single-look complex) and incoherent (multilook) polar decompositions are discussed. In single-look polar decomposition, we introduce the boost parameter and the rotation parameter with the purpose of classifying scattering mechanisms of different natures. New relationships between these geometrical parameters and the scattering matrix elements are obtained. We also briefly reexamine the standard coherent polarimetric target decomposition algorithms in the light of quaternions. Next, an original use of polar decomposition for incoherent polarimetric imaging is proposed, which leads to the definition of the multilook boost parameter and of the degree of polarization dispersion. Subsequently, a new approach is presented, which consists in decomposing the scattering matrix into boost and rotation components before vectorization, then in averaging to generate boost and rotation coherency matrices separately. This leads to new inferred parameters: the boost and rotation entropies, and the concurrent dominant scattering mechanisms. The link between these new parameters and standard polarimetric invariants from the Cloude and Pottier decomposition is discussed. Eventually, the multilook extension of polar decomposition may allow this to be applied to the classification of remote sensing data. In this framework, a set of five parameters reducing to four in the monostatic case can be considered. [J110]

"A Novel Direction-Finding Algorithm for Directional Borehole Radar"

A directional borehole radar system has been developed for the purpose of 3-D imaging of subsurface targets in a single-hole measurement. The radar system is equipped with a uniform circular array consisting of four dipole antennas as a receiver in order to realize azimuth bearing sensitivity. We propose a new direction-finding (DF) algorithm that is suitable for directional borehole radar measurement, and we apply this algorithm to actual field measurement data. This algorithm is based on the Adcock DF antenna principle where the complex time series (analytic signal) expression, the optimization, and the filtering procedure are incorporated to provide more accurate estimation. The algorithm was first verified in a transmission measurement in boreholes with a cross-hole configuration (15 m apart from each other) by estimating a direction of the incident wave from a transmitter to the receiver. Finally, the algorithm was applied to single-hole measurement data to demonstrate the ability to detect the 3-D location of a subsurface tunnel which was located 5.5 m from the borehole. The result showed fairly good agreement with the actual location of the tunnel, i.e., to an azimuth estimation error of within 10deg. [J111]

"An Efficient Volume Integral Equation Solution to EM Scattering by Complex Bodies With Inhomogeneous Bi-Isotropy"

A generalized volume integral equation method is formulated for electromagnetic scattering by arbitrarily shaped complex bodies with inhomogeneous bi-isotropy. Based on the volume equivalence principle, the integral equations are represented in terms of a pair of coupled bi-isotropic polarized volume electric and magnetic flux densities. Reduction of the integral equations into the corresponding matrix equations is obtained using the method of moments (MoM) combined with the tetrahedral mesh. In the MoM solution, the three-dimensional solenoidal function is incorporated as the basis function defined over each tetrahedral element and the details of implementation, particularly the treatment of integral singularities, will be elucidated. The efficiency and accuracy of the proposed method are validated by illustratively supported examples. [J112]

"Stationary Phase Derivation for RCS of an Ellipsoid"

This letter derives a factor needed to correct an omission in Ruck et al., Radar Cross Section Handbook, Vol. I & II, eq. (5.1-54), for the RCS of an ellipsoid. The derivation goes back to first principles to calculate geometrical optics (GO) expression for the RCS of an ellipsoid by evaluating the physical optics (PO) integral using the stationary phase method. It is shown there is a factor missing from Ruck's expression. Once this factor is included, the new expression for the bistatic RCS of an ellipsoid correctly reduces to the stated monostatic expression. The new expression also agrees with other published results for the bistatic RCS of the prolate

spheroid published Crispin and Siegel, methods of radar cross-section analysis, and Bowman, Senior, and Uslenghi, electromagnetic and acoustic scattering front simple shapes. It also reduces to the special case for RCS of a sphere when the major and minor axes are made equal. This new expression provides a consistent solution that corrects the previous omission and matches (for the special cases) all other previously published bistatic expressions. [J113]

"Non-parametric techniques for the estimation of spatial spectra in non-stationary environments"

A novel approach to the problem of estimating a spatial spectrum in a non-stationary environment has been presented. The approach adopted relies on the same principle as that which underpins the Wigner distribution. The proposed methodology results in the construction of a new sufficient statistic that can be used in conjunction with a variety of existing array-processing techniques. The resulting schemes are shown to be robust to source motions. Some of the limitations of this approach have been discussed and how they can be overcome is demonstrated. [J114]

"An Electrically Switchable Optical Ultrawideband Pulse Generator"

A novel electrically switchable optical ultrawideband (UWB) pulse generator that is capable of generating both Gaussian monocycle and Gaussian doublet pulses by using a polarization modulator (PolM) and a fiber Bragg grating is proposed and experimentally demonstrated. The polarity and the shape of the generated UWB pulses can be electrically switched by adjusting the voltages applied to two arbitrary wave plates (AWPs), which are incorporated at the input and the output of the PolM to adjust the polarization state of the lightwaves. The key component in the UWB pulse generator is the PolM, which is a special phase modulator that can support both transverse electric and transverse magnetic modes but with opposite phase modulation indexes. Depending on the polarization state of the incident lightwave to the PolM that is linearly polarized and aligned to one principle axis of the PolM or circularly polarized, UWB monocycle or doublet pulses are generated. The polarity of the UWB pulses can be electrically switched by adjusting the voltages applied to the AWPs. The proposed system is implemented, and the generation of UWB monocycle and doublet pulses is experimentally demonstrated. Gaussian monocycle and doublet pulses with a fractional bandwidth of about 150% and 160% are experimentally generated. The proposed electrically switchable optical UWB pulse generator has the potential for applications in UWB communications and radar systems that employ pulse polarity modulation and pulse shape modulation schemes. [J115]

"Wave Interferometry Applied to Borehole Radar: Virtual Multioffset Reflection Profiling"

Based on wave-interferometry principles, we describe a procedure to synthesize monostatic and multioffset borehole radar reflection data from cross-hole radar tomography data. The procedure is equivalent to placing multiple transmitting sources in the receiving hole and conducting wide-angle reflection and refraction surveys. The procedure is illustrated using transmission and reflection data generated by numerical simulation of electromagnetic waves for a simple fracture model. The numerically simulated reflection data compare favorably with the reflection data synthesized using the wave-interferometry method. An experimental test of this procedure is also applied to a piece of field data from a pair of boreholes in crystalline igneous bedrock. The results demonstrate the potential of practical use of wave-interferometry methods for extracting reflection information from cross-hole radar tomography data. [J116]

"Distance measurement sensor with PIN-photodiode and bridge circuit"

The presented integrated optical distance measurement sensor works on the time-of-flight principle. The distance information is obtained from the correlation of received light and the transmitted signal. The PIN-bridge circuit concept ensures suppression of background light by equally charging and discharging the capacitor within one period, while integrating the wanted signal. The advantages of the included PIN-photodiode are high bandwidth f3 dB>1.35 GHz together with high responsivity R=0.36 A/W at 660 nm. A single distance measurement is performed in 2 ms. With averaging, an accuracy of better than 1% is achieved for distances up to 3.7 m. Effective pixel size is 250Ч200 µm2having a fill-factor of 16%. The sensor was manufactured in a 0.6-µm BiCMOS process. [J117]

"High-resolution absolute position Vernier shaft encoder suitable for high-performance PMSM servo drives"

Permanent magnet synchronous motor (PMSM) drives are suitable for high-performance servo applications, as in robotics. This, however, requires an accurate position feedback, which is not possible with the existing absolute position encoders, unless one is prepared to compromise on the size of the encoder. This paper proposes a new encoding scheme based on the simple Vernier principle. The proposed scheme improves the resolution of the

encoder within limited disk diameter. An improved encoder based on the same principle is also presented with minor modifications to improve the resolution. Computer simulations and experimental work have shown that a suitable modification of the Vernier concept can result in an encoder that is superior to the existing ones. Details of this work are presented. [J118]

"UWB radar for human being detection"

UWB radar for detection and positioning of human beings in complex environment has been developed and manufactured. Novelty of the radar lies in its large operational bandwidth (11.7GHz at -10dB 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. Novel principle of human being detection is considered and verified experimentally. [J119]

"Ray tracing with PO/PTD for RCS modeling of large complex objects"

The present paper deals with a new efficient approach in order to assess the simulation of scattered fields from arbitrary metallic objects. The basic idea is to combine a ray tracing algorithm with the principles of physical optics (PO) and the physical theory of diffraction (PTD). The ray tracing algorithm stochastically launches discrete rays and uses a ray density normalization. In order to perform simulations at finite objects the PO/PTD formulation is required. Thus, fast intersection routines can be implemented, while the ray density formulation reduces the PO and PTD integrals to a pure sum of ray contributions. Simulation results obtained with this model are verified by comparison with both exact simulations using a method of moments (MoM) code and measurement results, proving an excellent accuracy and fast computation even at complex objects. With this asymptotic approach, scattering properties of large objects that are too complex for exact methods can be analyzed with rather moderate computation efforts. Typical applications include the simulation of low observability (LO) designs as well as the generation of databases for identifying unknown aircraft by their radar signature. [J120]

"Overview of generalized monopulse estimation"

Monopulse is an established technique for radar angle estimation. One can show that monopulse estimation is based on a general approximation derived from maximum likelihood (ML) estimation. This tutorial provides a derivation of this relation and presents extensions of this monopulse principle to multi-dimensional array and parameter estimation problems, in particular to space-time adaptive processing (STAP) with reduced dimension, subarrays and generalized sidelobe canceller (GSLC) configurations. The performance of these monopulse applications can be predicted by exploiting the distribution of the monopulse ratio. It is demonstrated that this distribution is more realistic than the Cramer-Rao bound (CRB). Several examples of performance of monopulse estimators are given for thinned and fully filled planar arrays, adaptive beamforming with and without low sidelobes, GSLC, and STAP. Finally, conditions for estimates with low variance are discussed [J121]

"Scattering-model-based speckle filtering of polarimetric SAR data"

A new concept in polarimetric synthetic aperture radar (POLSAR) speckle filtering that preserves the dominant scattering mechanism of each pixel is proposed in this paper. The basic principle is to select pixels of the same scattering characteristics to be included in the filtering process. To achieve this, the algorithm first applies the Freeman and Durden decomposition to separate pixels into three dominant scattering categories: surface, double bounce, and volume, and then unsupervised classification is applied. Speckle filtering is performed using the classification map as a mask. A single-look or multilook pixel centered in a 9 Ч 9 window is filtered by including only pixels in the same and two neighboring classes from the same scattering category. This filter is effective in speckle reduction, while perfectly preserving strong point target signatures, and retains edges, linear, and curved features in the POLSAR data. The effect of speckle filtering on scattering characteristics, such as entropy, anisotropy, and alpha angle, will be discussed. [J122]

"Ultrawideband radar imaging system for biomedical applications"

Ultrawideband (UWB) (3-10GHz)radar imaging systems offer much promise for biomedical applications such as cancer detection because of their good penetration and resolution characteristics. The underlying principle of UWB cancer detection is a significant contrast in dielectric properties, which is estimated to be greater than 2:1 between normal and cancerous tissue, compared to a few-percent contrast in radiographic density exploited by x rays. This article presents a feasibility study of the UWB imaging of liver cancer tumors, based on the frequency-dependent finite difference time domain method. The reflection, radiation, and scattering properties of UWB pulses as they propagate through the human body are studied. The reflected and back-scattered electromagnetic

energies from cancer tumors inside the liver are also investigated. An optimized, ultrawideband antenna was designed for near field operation, allowing for the reduction of the air-skin interface. It will be placed on the fat-liver tissue phantom with a malignant tumor stimulant. By performing an incremental scan over the phantom and removing early time artifacts, including reflection from the antenna ends, images based on the back-scattered signal from the tumor can be constructed. This research is part of our effort to develop a UWB cancer detection system with good detection and localization properties. [J123]

"Signal subspace change detection in averaged multilook SAR imagery"

This paper addresses change detection in averaged multilook synthetic aperture radar (SAR) imagery. Averaged multilook SAR images are preferable to full-aperture SAR reconstructions when the imaging algorithm is approximation-based (e.g., polar format processing) or when motion data are not accurate over a long full aperture. We examine the application of a SAR change-detection method, known as signal subspace processing, which is based on the principles of two-dimensional adaptive filtering, and we use it to recognize the addition of surface landmines to a particular area under surveillance. We describe the change-detection problem as a trinary hypothesis testing problem, and define a change signal and its normalized version to determine whether: 1) there is no change in the imaged scene; 2) a target has entered the imaged scene; or 3) a target has exited the imaged scene. A statistical analysis of the error signal is provided to show its properties and merits. Results are presented for averaged noncoherent multilook and coherent single-look X-band SAR imagery. [J124]

"Range resolution improvement of airborne SAR images"

This letter proposes an algorithm to improve the range resolution in airborne synthetic aperture radar (SAR) data by coherently combining an interferometric image pair, i.e., two images acquired with slightly different viewing angles. This algorithm is based on the wavenumber shift principle. In contrast to other methods, developed for application to spaceborne SAR data, the proposed algorithm takes the nonlinear effects due the strong variations in incidence angle in airborne SAR data into account. The proposed method is applied to SAR data of German Aerospace Center (DLR)'s E-SAR sensor. Quantitative verification results are obtained by measuring the resolution of several corner reflectors placed in the area under study, as well as the resolution of speckle of different areas. It is demonstrated that a resolution improvement of almost a factor of two can be achieved by incorporating a second interferometric image, which can be acquired easily with an airborne sensor. [J125]

"Inversion of a lidar waveform model for forest biophysical parameter estimation"

Due to its measurement principle, light detection and ranging (lidar) is particularly suited to estimate the horizontal as well as vertical distribution of forest structure. Quantification and characterization of forest structure is important for the understanding of the forest ecosystem functioning and, moreover, will help to assess carbon sequestration within forests. The relationship between the signal recorded by a lidar system and the canopy structure of a forest can be accurately characterized by physically based radiative transfer models (RTMs). A three-dimensional RTM is capable of representing the complex forest canopy structure as well as the involved physical processes of the lidar pulse interactions with the vegetation. Consequently, the inversion of such an RTM presents a novel concept to retrieve biophysical forest parameters that exploits the full lidar signal and underlying physical processes. A synthetic dataset and data acquired in the Swiss National Park (SNP) successfully demonstrated the feasibility and the potential of RTM inversion to retrieve forest structure from large-footprint lidar waveform data. The SNP lidar data consist of waveforms generated from the aggregation of small-footprint lidar returns. Derived forest biophysical parameters, such as fractional cover, leaf area index, maximum tree height, and the vertical crown extension, were able to describe the horizontal and vertical forest canopy structure. [J126]

"Validating the SAR Wavenumber Shift Principle With the ERS–Envisat PS Coherent Combination"

Continuity of the European Remote Sensing Satellite Synthetic Aperture Radar (ERS SAR) archive by means of Envisat Advanced SAR (ASAR) data acquired from March 2002 has introduced the problem of the coherent combination of images coming from sensors with slightly different frequencies. The spectral shift principle states that in case of extended distributed targets, the frequency shift is equivalent to a change of looking angle. In this paper, the same principle is exploited to analyze the behavior of permanent scatterers (PSs) with an extension that is smaller than the ground resolution cell. The conditions under which the PSs identified by ERS can be continued by Envisat are then theoretically determined and experimentally validated. Moreover, this analysis shows that acquisitions characterized by different frequencies can be used to identify the slant-range position of scatterers with high subcell accuracy (tens of centimeters). From the processing side, a very precise images coregistration step is required to get the results described in this paper [J127]

"Imaging Simulation of Polarimetric SAR for a Comprehensive Terrain Scene Using the Mapping and Projection Algorithm"

A novel approach to polarimetric image simulation for synthetic aperture radar (SAR) observation over comprehensive terrain scenes is developed based on mapping and projection principles. It incorporates penetrable and impenetrable objects, volumetric and surface scatterers in the imaging space with extinction, attenuation, shadowing, and multiple-scattering effects. Scattering of the vegetation canopy is modeled as a layer of random nonspherical particles by using the vector radiative transfer model, and scattering from the ground surface and building objects is calculated by using the integral equation method. As an example, polarimetric SAR images at L-band and C-band and the different spatial resolutions for a virtual terrain scene composed of tree canopies, farmland, buildings, rough land surface, hills, and rivers are simulated. The imaging simulation results demonstrate the feasibility of the mapping and projection approach and the potential utilities of SAR imaging simulation [J128]

"HFSWR based on synthetic impulse and aperture processing"

A novel high-frequency surface wave radar (HFSWR) has been proposed, which is based on the principles of synthetic impulse and aperture processing. It uses multiple omnidirectional transmit antennae to simultaneously transmit a set of orthogonal waveforms, and the echoed signals are received and processed by one or multiple reception arrays. Although the transmit beam pattern is omnidirectional, by proper processing, the received signal multiple equivalent directional transmit beam patterns can be simultaneously formed. The signal processing scheme to obtain equivalent directional transmit beam pattern is investigated in detail. Considerations for system parameter selection to achieve an overall best system performance are proposed and discussed. In particular, for the novel HFSWR, target range and angle estimates are coupled together due to the orthogonality of the transmitted waveforms. A necessary and sufficient condition on the transmit antenna array geometry and transmit frequencies, which ensures that target range and angle estimates are uncoupled, is presented [J129]

"On the Usage of GRECOSAR, an Orbital Polarimetric SAR Simulator of Complex Targets, to Vessel Classification Studies"

This paper presents a synthetic aperture radar (SAR) simulator that is able to generate polarimetric SAR (POLSAR) and polarimetric inverse SAR data of complex targets. It solves the electromagnetic problem via high-frequency approximations, such as physical optics and the physical theory of diffraction, with notable computational efficiency. In principle, any orbital monostatic sensor working at any band, resolution, and operating mode can be modeled. To make simulations more realistic, the target's bearing and speed are considered, and for the particular case of vessels, even the translational and rotational movements induced by the sea state. All these capabilities make the simulator a powerful tool for supplying large amounts of data with precise scenario information and for testing future sensor configurations. In this paper, the usefulness of the simulator on vessel classification studies is assessed. Several simulated polarimetric images are presented to analyze the potentialities of coherent target decompositions for classifying complex geometries, thus basing an operational algorithm. The limitations highlighted by the results suggest that other approaches, like POLSAR interferometry, should be explored [J130]

"Time-frequency method for detecting an accelerating target in sea clutter"

The authors design a time-frequency (TF) method for use in high-frequency surface-wave radar (HFSWR) for detecting a small accelerating target in sea clutter. The clutter is modelled by pseudo targets moving with Bragg velocity towards and away from the radar. The design is based on the Wigner distribution (WD) defined by Chan (type-III WD, in our terminology) rather than the WD defined by Claasen and Mecklenbrauker (1980) (2times type-I WD, in our terminology). Like the type-I WD, the type-III WD also concentrates a chirp signal onto a straight line in the TF plane. The type-III WD has the following advantages: 1) Its range of unambiguously measurable frequencies (RUMF) is [-pi,pi] rad/s, whereas for the type-I WD the RUMF is [-pi/2,pi/2] rad/s. 2) It allows a target separated from the clutter by pi rad/s to be detected, whereas the type-I WD coalesces such a target with the clutter and thereby mask it. An ambiguity function (AF) was defined corresponding to the type-III WD and use it to derive a smoothed type-III WD that mitigates the clutter. The smoothed type-III WD method is applied to real radar data and shown to be superior to the conventional Fourier transform method. The advantages of the type-III WD over the type-I WD are also demonstrated. The design principles laid out in the paper can also be used to develop a TF method for use in air traffic control radar (ATCR) for detecting an accelerating target in land clutter [J131]

"UWB Radar for Human Being Detection"

UWB radar for detection and positioning of human beings in complex environment has been developed and

manufactured. 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 until 12 GHz. Novel principle of human being detection is considered and verified experimentally [J132]

"Investigations on the polarimetric behavior of a target near the soil"

The polarimetric behavior of the diffracted field from an object located close to the ground is investigated for a varying incidence angle. Here, the field is described by the geometrical theory of diffraction in accordance to its asymptotic formulas (krarrinfin). As a result, a ray system composed of 13 different rays was implemented for the monostatic case by applying the principle of Fermat. The different spatial and creeping waves give a physical insight in the mechanisms involved in the entire scattering process. By varying the angle from perpendicular to grazing incidence 0deg-90deg, geometrical surface shadow boundaries are present for the backscattered field. At such boundaries, the spatial waves are replaced by their corresponding creeping waves, leading to a strong attenuation. The diffracted field for look angles related to the transition zones has a characteristic polarimetric behavior, which can be represented on the Poincare sphere. The typical locations on the sphere can be exploited to get information about the geometrical parameters of the target and its height above the ground [J133]

"Lossless Information Fusion for Active Ranging and Detection Systems"

The authors develop a centralized information fusion architecture from basic principles of information theory and Bayesian statistics. It is well known that any clustering, quantizing, or thresholding of data causes loss of information unless a sufficient statistic is computed in the processing. For the case of wideband active ranging systems, the coherent output of an optimum beamformer and a matched filter is a sufficient statistic that can be transmitted to the fusion center. For unknown target velocity, range, and bearing, the wideband space-time matched filter output can be interpreted as a multidimensional wavelet transform or a delay-scale-bearing map. In this paper, a Bayesian, joint estimation-detection approach is used for computation of sufficient statistics and multisensor information fusion. An approach borrowed from sequential Bayesian processing is used to compute prior densities for joint Bayesian estimation-detection. In this approach, a posteriori densities become priors after a coordinate transformation that transforms the outputs of each sensor to a common reference frame for all sensors. Reproducing prior densities are used to simplify Bayesian computation [J134]

"Very Fast Rise-Time Short-Pulse High-Voltage Generator"

This paper relates to the development of an ultrafast compact system readily applicable to the field of ultrawideband microwave applications such as transient radar or laser drivers. The design, production, and experimental results of a short-pulse generation system are presented in this paper. The coaxial generator technology based on the principle of a line discharge by means of a high-pressure gas switch in a simple transmission line arrangement is described. In the first stage of the process, the coaxial generator was charged by a high-voltage direct current source. Interesting results were obtained, but due to the jitter of the discharge formative time, the reproducibility of the output pulses was not sufficient. To improve the performance, a pulsed source was developed in order to apply an overvoltage to the gap switch and thus reduce the jitter of the discharge formative time. The characteristics of the pulsed source are defined. A thyristor Marx generator and a pulse transformer using magnetic properties of ferrite cores were combined in order to produce this pulsed source. The main performances of this source are a pulse amplitude of 60 kV, a rise time of 250 ns, and a maximum frequency of 900 Hz from a 1-kV dc supply. Finally, the complete generation system is able to generate pulses with 25-kV amplitude and 70-ps rise time through a 50-Omega impedance from the single shot mode up to 900 Hz. The output pulses reproducibility obtained is better than plusmn5% [J135]

"Automatic ground target classification using forward scattering radar"

Experimental study is undertaken of the feasibility of forward scattering radar (FSR) and its application to automatic ground target classification. The radar itself, fundamental theoretical analysis, target recognition algorithm and the target's classification subsystem are introduced. For target recognition, the effect of shadow inverse synthetic aperture radar is used. The radar experimental set-up and experimentation results are discussed. For classification, a system is proposed, which extracts features from the radar measurements by using Fourier transform and principle component analysis and uses a nearest neighbour classifier. Speed estimation in FSR is also introduced. By analysing 850 experimentally obtained car signatures, the performance of the system is evaluated and the effectiveness of the system is confirmed. The limitations of the work and its future are also discussed [J136]

"Tunable thin radar absorber using artificial magnetic ground plane with variable backplane"

Experimental verification is provided of the frequency tuning capability of a low-profile radar absorber material based on the high impedance surface principle. The absorber consists of an artificial magnetic ground plane with surface mount resistors interconnecting a textured surface of square patches. It is shown that by displacing the ground plane of the textured surface substrate from 0 to 0.04lambda obetter than -15 dB return loss, -42 dB best case, from 3.55 to 5.47 GHz can be obtained when the surface is illuminated by a linearly polarised signal at normal incidence to the surface. In addition, the response of the surface in terms of its axial ratio performance under circular polarised signal excitation at normal incidence is investigated for a fixed ground displacement [J137]

"Object detection via feature synthesis using MDL-based genetic programming"

In this paper, we use genetic programming (GP) to synthesize composite operators and composite features from combinations of primitive operations and primitive features for object detection. The motivation for using GP is to overcome the human experts' limitations of focusing only on conventional combinations of primitive image processing operations in the feature synthesis. GP attempts many unconventional combinations that in some cases yield exceptionally good results. To improve the efficiency of GP and prevent its well-known code bloat problem without imposing severe restriction on the GP search, we design a new fitness function based on minimum description length principle to incorporate both the pixel labeling error and the size of a composite operator into the fitness evaluation process. To further improve the efficiency of GP, smart crossover, smart mutation and a public library ideas are incorporated to identify and keep the effective components of composite operators. Our experiments, which are performed on selected training regions of a training image to reduce the training time, show that compared to normal GP, our GP algorithm finds effective composite operators more quickly and the learned composite operators can be applied to the whole training image and other similar testing images. Also, compared to a traditional region-of-interest extraction algorithm, the composite operators learned by GP are more effective and efficient for object detection. [J138]

"A gateway approach to mobility integration of GPRS and wireless LANs"

This article presents a gateway approach to the integration of GPRS and wireless LANs (WLANs). The proposed architecture leverages mobile IP as the mobility management protocol over WLANs. The interworking between GPRS and WLANs is achieved by a gateway that resides on the border of GPRS and WLAN systems. The design goal is to minimize the modifications in GPRS and WLANs as both systems are widely available in the market already. By deploying the gateway, users can seamlessly roam among the two systems. The proposed architecture and design principles have been implemented in a commercial GPRS network operated by the Taiwan Cellular Corporation. Empirical experiments with multimedia applications were conducted to analyze the performance in terms of handoff latency, packet delay, and throughput. [J139]

"An integral method for extremely low frequency magnetic shielding"

A novel approach for analyzing conducting shields of extremely low frequency magnetic fields in linear media is presented. It consists of an integral formulation based on the cell method, expressed in terms of network-like loop currents and magnetic vector potential line integrals on the shield surface. This formulation leads to a considerable reduction of field problem variables, thus limiting the amount of allocated memory and speeding-up the numerical procedure compared to other differential and integral techniques. Eddy currents are computed first, then the magnetic vector potential and the magnetic flux density distributions are evaluated by applying the superimposition principle. A detailed comparison between this method and a three-dimensional finite element method code demonstrates the accuracy of the results and the advantages of the method. [J140]

"Bounds on maximum likelihood ratio-Part II: application to antenna array detection-estimation with imperfect wavefront coherence"

The maximum likelihood ratio (LR) lower bound analysis introduced in our previous papers is applied to support the detection-estimation of multiple Gaussian spread (distributed, scattered) sources. Since angular spreading eliminates any "noise eigensubspace" from the spatial covariance matrix, traditional detection techniques based on the equality of noise-subspace eigenvalues are not applicable here. Brute-force "focusing", which is based on the Schur-Hadamard inverse, is shown to be inefficient. Our technique is based on generalized likelihood-ratio test (GLRT) principles and involves LR maximization over the set of admissible covariance matrix models. The introduced technique yields results that statistically exceed the LR generated by the exact covariance matrix, which is used as the lower bound. High optimization efficiency drives high detection-estimation performance that, nevertheless, breaks down under certain threshold conditions. It is demonstrated that this breakdown

phenomenon is not curable within the maximum likelihood (ML) paradigm since these highly erroneous solutions are still "better" than the true covariance matrix (as measured by the LR). [J141]

"Measurement of river surface currents with coherent microwave systems"

River surface currents have been measured using coherent microwave systems from a bridge, a cableway, several riverbanks, a helicopter, and an airplane. In most cases, the microwave measurements have been compared with conventional measurements of near-surface currents and found to be accurate to within about 10 cm/s. In all cases, the basis for the microwave measurement of surface current is the Doppler shift induced in the signal backscattered from the rough water surface. In this paper, we outline the principles of the measurements and the various implementations that have been used to make microwave measurements of surface currents. Continuous-wave (CW) microwave systems have been used from a bridge to make long-term measurements of surface currents; these are compared with current-meter measurements and with time series of stage. A compact CW system has been developed and used on a cableway to measure surface currents at various distances across a river; these measurements have been compared with acoustic ones. Pulsed Doppler radars have been used to measure river surface currents from a riverbank, a helicopter, and an airplane. In the first two cases, comparisons with both current-meter and acoustic measurements have been made. We suggest that the CW system would be preferable to the pulsed Doppler radar to make such measurements from helicopters in the future. Finally, we consider the implications of our experiments for the measurement of surface currents from aircraft or satellites using interferometric synthetic aperture radars (INSARs). We find that a combination along-track, cross-track INSAR is necessary but that significant limitations are inherent in the technique. [J142]

"Use of modulated excitation signals in medical ultrasound. Part I: basic concepts and expected benefits"

This paper, the first from a series of three papers on the application of coded excitation signals in medical ultrasound, discusses the basic principles and ultrasound-related problems of pulse compression. The concepts of signal modulation and matched filtering are given, and a simple model of attenuation relates the matched filter response with the ambiguity function, known from radar. Based on this analysis and the properties of the ambiguity function, the selection of coded waveforms suitable for ultrasound imaging is discussed. It is shown that linear frequency modulation (FM) signals have the best and most robust features for ultrasound imaging. Other coded signals such as nonlinear FM and binary complementary Golay codes also have been considered and characterized in terms of signal-to-noise ratio (SNR) and sensitivity to frequency shifts. Using the simulation program Field II, it is found that in the case of linear FM signals, a SNR improvement of 12 to 18 dB can be expected for large imaging depths in attenuating media, without any depth-dependent filter compensation. In contrast, nonlinear FM modulation and binary codes are shown to give a SNR improvement of only 4 to 9 dB when processed with a matched filter. Other issues, such as depth-dependent matched filtering and use of filters other than the matched filter (inverse and Wiener filters) also are addressed. [J143]

"Sea ice mapping method for SeaWinds"

A sea ice mapping algorithm for SeaWinds is developed that incorporates statistical and spatial a priori information in a modified maximum a posteriori (MAP) framework. Spatial a priori data are incorporated in the loss terms of a Bayes risk formulation. Conditional distributions and priors for sea ice and ocean statistics are represented as empirical histograms that are forced to conform to a set of expected histograms via principal component filtering. Tuning parameters for the algorithm allow adjustments in the algorithm's performance. Results of the algorithm exhibit high correlation with the Remund-Long sea ice mapping algorithm for SeaWinds and the Special Sensor Microwave/Imager National Aeronautics and Space Administration Team 30% ice edge, and are verified with RADARSAT-1 ScanSAR imagery. The resulting sea ice maps exhibit high edge detail, preserve polynyas and ice bodies disjoint from the primary ice sheet, and thus are suitable for use with wind retrieval and sea ice studies. Principles employed in the algorithm may be of interest in other classification studies. [J144]

"Efficient analysis of antenna radiation in the presence of airborne dielectric radomes of arbitrary shape"

A technique based on the surface integral equation is applied for the analysis of antenna radiation in the presence of an arbitrarily shaped dielectric radome terminated by a conducting surface. The equivalence principle is used to characterize the effect of the radome on the transmitted field in terms of equivalent surface electric and magnetic currents which radiate in an unbounded medium. A set of coupled integral equations involving these currents is obtained by using the boundary conditions on the tangential components of the total

fields. The adaptive integral method is applied to solve the integral equations so that electrically large radomes can be analyzed. The radiation patterns of dipole arrays with dielectric radomes of superspheroidal shape are also presented. [J145]

"Method of moments solution for the radar cross section of a chiral body of revolution"

The problem of electromagnetic scattering from an arbitrary homogeneous chiral body of revolution is formulated using the surface equivalence principle and is solved numerically by the method of moments. The numerical solution is implemented by means of a general computer program written for chiral bodies of revolution. Numerical results are given for bistatic radar cross sections of a chiral sphere. These results agree well with exact results obtained by the eigenfunction solution. [J146]

"The six-port as a communications receiver"

Configurable radio terminals require receivers with wide-band capabilities in order to support as many services as possible at most different carrier frequencies. Conventional well-known receiver architectures employing active circuitry are limited in this respect. Therefore, alternative architectures are investigated, such as the six-port, which has been introduced as a very flexible and elegant means for microwave measurements in the 1960s and 1970s. Later on, it has been used in radar applications. It was not until recently that communications receivers have been built upon the six-port principle. However, in all publications, there is always a certain mystic about the six-port. It has even been described as a "black box". In order to help paving the way for a wider application of the six-port technology, this paper describes the basic six-port theory and sets it into relation with the conventional receiver architectures such as the homodyne and heterodyne receiver. Finally, the advantages and possible applications of receivers based on the six-port technology are discussed. [J147]

"The advanced multifunction RF concept"

The goal of the Advanced Multifunction Radio Frequency Concept (AMRFC) Program is to demonstrate the integration of many sorts of shipboard RF functions including radar, communications, and electronic warfare (EW) utilizing a common set of broad-band array antennas, signal and data processing, signal generation, and display hardware. The AMRFC Program was launched in response to the growing number of topside antennas on U.S. Navy ships, which have almost doubled from the ships launched in the 1980s to those launched in the 1990s. The AMRFC Program seeks to develop and demonstrate a wide-band generic active array antenna architecture that has the ability to transmit and receive multiple simultaneous independent beams for radar, EW, and communication functions. This paper describes a proof-of-principle test-bed that is being developed to demonstrate the AMRFC. [J148]

"Integration of optical and radar classifications for mapping pasture type in Western Australia"

In this study, independent classifications of Landsat Thematic Mapper imagery and Jet Propulsion Laboratory AirSAR were combined to create an integrated classification of pasture and other vegetation types for a study area in the agricultural zone of Western Australia. The resulting classification combines greenness and brightness information from optical data with structure and water content information from synthetic aperture radar (SAR). Field observations of vegetation type, botanical composition, ground cover percentage, wet and dry biomass, canopy height, and soil water content were collected at 34 sites representing a range of pastures, browse shrubs, and crops. An unsupervised version of the Complex Wishart classification procedure, based on preserving scattering characteristics from the Freeman and Durden backscatter decomposition, was applied to the C-, L-, and P-band polarimetric SAR data. The optical classification was carried out using a principle component analysis on the green, red, and near-infrared bands and clustering on the basis of a class centroid distance measure and knowledge of ground targets. These two classification results were then fused together. Assessment of a confusion matrix using the individual sites showed that identification of more uniform, dense, and structurally distinct canopies was better than that of more diverse, sparse, and structurally ambiguous canopies, as the former were better represented by the canopy height attribute used in the SAR classification component. The optical classification enabled correction of SAR misclassification of vegetation due to surface roughness and soil moisture effects, or similar backscatter responses from herbaceous or arboreal canopies. The results show that simplification of vegetation into groups based upon properties with sensitive responses in both the optical and SAR domains, and combination of separate SAR and optical classifications, has potential for improving classification of diverse and heterogeneous herbaceous and browse cover in grazing lands. However, collection of ground calibration data must be at an appropriate spatial scale and include canopy and surface measurements directly related to backscatter mechanisms and spectral sensitivity. [J149]

"Sea surface velocity vector retrieval using dual-beam interferometry: first demonstration"

The dual-beam interferometer consists of two interferometric synthetic aperture radars (InSARs), one squinted at 20° forward of broadside, and the other 20° aft, to allow measurement of vector surface velocity with only a single aircraft pass. Estimates of surface velocity vectors in the coastal region during high tidal flow are presented. The data were gathered over the barrier islands west of Fort Myers, Florida, as part of a March 2004 deployment. Whereas no detailed bathymetry data were available, high-quality aerial photography appears to be a useful tool in inferring bottom topography and possible current obstructions. The retrieved velocity field clearly follows the expected outflow pattern. While comparisons with tidal current magnitudes predicted by the U.S. National Ocean Service do reveal discrepancies of up to 0.5 m/s, these differences are most likely due to the contribution of ocean surface waves to the overall InSAR velocity measurement. Velocity retrievals for the same area based on the data from different tracks show good consistency. The results constitute the first demonstration of vector retrieval of the surface velocity field with a single-pass InSAR system and confirm the robustness of the dual-beam interferometry principle. [J150]

"Simulated Radar imagery of an ocean "Spiral Eddy""

Ocean submesoscale features appear to be widespread in the surface mixed layer and thus may be an important link in the energy pathway from large to small scales. An example is the "spiral eddy," for which several theories have been proposed. High-resolution radar imagery should be useful in testing these theories, but there have as yet been no simulations of radar imagery from first principles. As a step in this direction, we developed a capability to simulate imagery using a full-spectral calculation that includes the effects of both wave-current interaction and wave damping due to a surface film. A particular model of a spiral eddy is used to specify the surface velocity field and film distribution. Imagery is then simulated for a range of radar frequencies, wind speeds, initial film pressures, and relative radar view directions. For winds of 3-8 m/s and an initial film pressure of 0.5 mN/m, imagery for shorter radar wavelengths (X- and C-band) is dominated by the effects of film damping. For longer wavelengths (L- and P-band) wave-current interactions and film damping are of comparable magnitude; but for higher initial film pressures, the L- and P-band images also become dominated by film damping. L-band imagery, in particular, is highly sensitive to the initial value of film pressure, and such a result may have implications for determining properties of seawater films. Overall, the radar simulations produce surface patterns having characteristics that resemble radar imagery of real ocean spiral eddies. [J151]

"Theory and analysis of adaptive cylindrical array antenna for ultrawideband wireless communications"

In this paper, the principle of cylindrical array beamforming based on ultrawideband impulse (UWBI) signals is introduced. A cylindrical array antenna is composed of a number of vertically aligned and concentric circular subarrays of equal radius and equal number of array elements. Theory, analysis, and computer simulation of the cylindrical array antenna are presented based on UWBI signals with the time variation of a generalized Gaussian pulse (GGP). The radiation pattern of the cylindrical array antenna is derived in terms of the inverse Fourier transform of the radiated far-zone GGP signal. The radiation pattern results in different azimuth and elevation beam patterns such as peak amplitude pattern, peak power pattern, and energy pattern. Computer plots of these antenna patterns are generated for different design parameters such as array radius, interelement spacing distance, frequency bandwidth, and steering angle. The phenomenon of beamwidth broadening associated with electronic beamsteering is analyzed, and the resolution angle for the cylindrical array antenna is derived too. Beamforming based on UWBI signals provides a tradeoff between array dimensions, frequency bandwidth, and steering angle for achieving a high angular resolution capability in the azimuth plane as well as in the elevation plane. Such a tradeoff is attractive in practice for UWBI communications, indoor (multimedia) communications, radar, and localization systems. [J152]

"W-band airborne interrupted frequency modulated CW imaging radar"

A 94 GHz imaging radar-based on the interrupted FMCW (FMICW) principles, with its associated gimbals for stabilization and scanning has been developed as an airborne test-bed to evaluate radar-aided navigation and guidance algorithms. Preliminary results from helicopter-based flight tests show sufficient contrast between selected features (including runways) and their surroundings for both computer- and human-pilot-based guidance. Feature extraction and matching algorithms have shown this system to be more accurate than GPS. [J153]

"Stereoscopic Passive Millimeter-Wave Imaging and Ranging"

This paper presents the first stereoscopic range measurements at a wavelength of 3.3 mm and discusses the accuracy of this new method. The synthesis of passive millimeter-wave imaging and stereoscopy combines the advantages of both principles, naturally looking high-contrast images and superior poor-weather performance

(compared to visible and infrared wavelengths), as well as the passive ranging capability. Our setup using two antennas with a half-power beamwidth (HPBW) of 0.9$^circ$and a stereoscopic baseline of 1.15 m allows ranging with an accuracy of$approxhbox10hbox%$up to a distance of$approx$300 m. The range resolution improves with increasing stereoscopic baseline, lower radiometer noise, narrower antenna beams, and higher scene contrast. For scenes with sufficient contrast, the directional resolution is considerably better than the antenna HPBW. Thus, massive oversampling of the scene in the plane of the stereoscopic baseline is required. For our setup, an oversampling factor of 36 is optimal. Since additional ranging errors result from nonstationary scenes, fast scanning imagers should be applied. [J154]

"Design of sharp-rejection and low-loss wide-band planar filters using signal-interference techniques"

A new class of sharp-rejection, low insertion-loss wide-band planar filters is presented in this letter. The proposed filter topology uses transversal signal-interference filtering sections made up of two transmission-line segments connected in parallel. Thus, under signal-interaction principles, the filtering action comes about through the generation of multiple out-of-band power transmission zeros and constructive in-passband signal combinations. Design equations and guidelines to adjust both the bandwidth and the out-of-band performance of the filtering response through the design parameters of the transversal section are also provided. Furthermore, the theoretical results are validated with the manufacture and characterization of an ultra-wideband microstrip filter prototype at 5 GHz. [J155]

"A novel surface plasmon resonance immunosensor for 2,4,6-trinitrotoluene (TNT) based on indirect competitive immunoreaction: a promising approach for on-site landmine detection"

A surface plasmon resonance (SPR) immunosensor for the determination of 2,4,6-trinitrotoluene (TNT) has been developed based on the principle of indirect competitive immunoreaction. 2,4,6-trinitrophenol-bovine serum albumin (TNP-BSA) conjugate was immobilized onto a SPR gold chip by means of simple physical adsorption. Binding of anti-TNP antibody with TNP-BSA conjugate was detected based on an increase in resonance angle due to antigen-antibody interaction. Preincubation of anti-TNP antibody with TNT suppresses its interaction with immobilized TNP-BSA conjugate, which leads to a decrease in resonance angle shift. Following the dependence of the resonance angle shift, concentration of TNT was detected. Pepsin solution was used for the regeneration of the sensing surface. The response time for TNT measurement is about 22 min. The immunosensor showed excellent sensitivity to TNT in a wide concentration range from 60 ppt to 1000 ppb with good selectivity, stability, and reproducibility. The proposed system is promising for future application for the on-site detection of landmines. [J156]

"Reply to comments on "Interference from 24-GHz automotive radars to passive microwave Earth remote sensing satellites""

We appreciate that authors Kerr et al. concur that our paper [ibid., vol.42, no.7, p.1387-98 (2004)] provides the right approach to the analysis of potential interference from anthropogenic sources to remote sensing satellites. The potential for such interference is likely to grow as new active systems are developed, necessitating acceptable procedures for interference analysis based on accepted scientific knowledge and engineering principles. While some simple clarifications are in order to improve the acceptability of our procedure, we suggest, however, that Kerr et al. have not studied our paper in detail and misinterpret several points. [J157]

"IWRAP: the Imaging Wind and Rain Airborne Profiler for remote sensing of the ocean and the atmospheric boundary layer within tropical cyclones"

The Imaging Wind and Rain Airborne Profiler (IWRAP) is the first high-resolution dual-band airborne Doppler radar designed to study the inner core of tropical cyclones (TCs). IWRAP is operated from a National Oceanic and Atmospheric Administration WP-3D aircraft during missions through TCs and severe ocean storms. The system is designed to provide high-resolution dual-polarized C- and Ku-band reflectivity and Doppler velocity profiles of the atmospheric boundary layer (ABL) within the inner core precipitation bands of TCs and to study the effects precipitation has on ocean wind scatterometry as it applies to TCs. IWRAP implements a very unique measurement strategy; it profiles simultaneously at four separate incidence angles (approximately 30°, 35°, 40°, and 50°) while conically scanning at 60 rpm. A summary of the principles of operation and the design of the instrument is given, followed by examples of IWRAP's unique imaging capability. To our knowledge, these examples include the highest resolution measurements of the ABL winds in a hurricane ever obtained. [J158]

"A spatially selective approach to Doppler estimation for frame-based satellite SAR processing"

When Doppler centroid estimators are applied to satellite synthetic aperture radar (SAR) data, biased estimates are often obtained because of anomalies in the received data. Typical anomalies include areas of low SNR, strong discrete targets, and radiometric discontinuities. In this paper, a new method of Doppler centroid estimation is presented that takes advantage of principles such as spatial diversity, estimator quality checks, geometric models, and the fitting of a "global" estimate over a wide area of a SAR scene. In the proposed scheme, Doppler estimates are made over small blocks of data covering a whole frame, so that all parts of the scene are potentially represented. The quality of each block estimate is examined using data statistics or estimator quality measures. Poor estimates are rejected, and the remaining estimates are used to fit a surface model of the Doppler centroid versus the range and azimuth extent of the scene. A physical model that relates the satellite's orbit, attitude, and beam-pointing-direction to the Doppler centroid is used to get realistic surface fits and to reduce the complexity (dimensionality) of the estimation problem. The method is tested with RADARSAT-1 and Shuttle Radar Topography Mission X-band SAR (SRTM/X-SAR) spaceborne data and is found to work well with scenes that do have radiometric anomalies, and in scenes where attitude adjustments cause the Doppler to change rapidly. [J159]

"Three-dimensional SAR imaging of a ground moving target using the InISAR technique"

In this paper, a three-dimensional (3-D) interferometric synthetic aperture radar (ISAR) imaging method for moving targets is presented. This imaging method is based on the ISAR principle and the simple observation that all scatterers on a moving target move in tandem. The angular motion parameters in the cross-range directions could be estimated using the overall range profile of the moving target. Registration of the respective complex images at the two (or more) interferometric antennas can then be achieved via compensating the respective echoes at the raw data level, thus avoiding phase-unwrapping processing and image-resampling processing as required by conventional methods. Finally, a 3-D image of the moving target can then be reconstructed from the 3-D spatial coordinates of these scatterers. Furthermore, the method works well even for a target moving in heavily cluttered environments. [J160]

"A fast recursive total least squares algorithm for adaptive FIR filtering"

This paper proposes a new fast recursive total least squares (N-RTLS) algorithm to recursively compute the TLS solution for adaptive finite impulse response (FIR) filtering. The N-RTLS algorithm is based on the minimization of the constrained Rayleigh quotient (c-RQ) in which the last entry of the parameter vector is constrained to the negative one. As analysis results on the convergence of the proposed algorithm, we study the properties of the stationary points of the c-RQ. The high computational efficiency of the new algorithm depends on the efficient computation of the fast gain vector (FGV) and the adaptation of the c-RQ. Since the last entry of the parameter vector in the c-RQ has been fixed as the negative one, a minimum point of the c-RQ is searched only along the input data vector, and a more efficient N-RTLS algorithm is obtained by using the FGV. As compared with Davila's RTLS algorithms, the N-RTLS algorithm saves the 6M number of multiplies, divides, and square roots (MADs). The global convergence of the new algorithm is studied by LaSalle's invariance principle. The performances of the relevant algorithms are compared via simulations, and the long-term numerical stability of the N-RTLS algorithm is verified. [J161]

"Cascade lasing of molecular HBr in the four micron region pumped by a Nd:YAG laser"

Due to a narrow window of high atmospheric transmission near 4 μm there is a great deal of interest for a scalable laser energy source in this spectral region. We propose a concept combining the advantages of solid-state and gas laser technology. It takes advantage of a coincidence of a Nd:YAG laser line and an overtone transition of the molecule HBr. Tuning a Q-switched Nd:YAG laser to 1.3391 μm allows us to excite the v(0 → 3), J(4 → 5) vibrational-rotational transition of HBr. To stabilize the pump frequency, a diode laser locked to this HBr transition seeds the Nd:YAG laser. Once excited, HBr can potentially lase in three subsequent steps to the ground state, two of which were observed experimentally, emitting up to three photons in the 4-μm region. We present theoretical and experimental results demonstrating the operational principle of this laser system. The comparison of experiment and theory suggests: 1) that intracavity CO2can force the system to lase on only those transitions that are within the atmospheric transmission window, and 2) the existence of amplified spontaneous emission driven by pure rotational transitions. [J162]

"Numerical simulation of bistatic scattering from a target at low altitude above rough sea surface under an EM-wave incidence at low grazing angle by using the finite element method"

To study bistatic scattering from a target at low altitude above two-dimensional (2-D) randomly rough sea surface under an electromagnetic (EM) wave incidence at low grazing angle (LGA), a numerical approach of the finite element method (FEM) is developed. The conformal perfectly matched layer (PML), as the truncation

boundary of the FEM, is employed to reduce the reflection error of planar PML in conventional FEM. Numerical code of our FEM is examined by available solution of the FBM (forward backward iterative) method. Bistatic and back-scattering from composite model of a target above randomly rough sea surface generated by Monte Carlo realization, and functional dependence upon the sea surface wind speed, target altitude, incident and scattering angles etc. are numerically demonstrated and discussed. This study presents numerical description for the observation principle and physical insight associated with the coupling interactions of a complex volumetric target and randomly rough sea surface. [J163]

"Dynamics and radar cross section density of chaff clouds"

A new chaff cloud model (CCM) is described which is based on fundamental principles with modifications based on laboratory observations. Excellent approximations to the exact physical model have been developed which can rapidly predict the chaff fiber density and orientation as a function of location, time and fiber characteristics. Using this information, the time varying radar cross section (RCS) density is determined for any frequency and polarization anywhere within the chaff cloud. The results are consistent with full scale observations, and the computational speed allows the model to be integrated into existing real time radar simulations. [J164]

"Unifying regularization and Bayesian estimation methods for enhanced imaging with remotely sensed Data-part I: theory"

The problem of estimating, from one sampled realization of the remotely sensed data signal, the power spatial spectrum pattern (SSP) of the wave field scattered from the probing surface is treated as it is required for enhanced radar imaging of the remotely sensed scenes. Specifically, we propose to unify the Bayesian estimation strategy with the maximum-entropy (ME) information-theoretic principle for incorporating the prior knowledge through developing the fused Bayesian-regularization (FBR) technique for SSP estimation. The first aspect of the proposed approach concerns the ME-based incorporating the a priori information about the geometrical properties of an image to tailor the metrics structure in the solution space to the problem at hand. The second aspect alleviates the problem ill-posedness associated with preserving the boundary values, calibration, and spectral a priori fixed model properties of an image through the regularizing projection constraints imposed on the solution. When applied to SSP estimation without incorporating the metrics and regularization considerations, the procedure leads to the previously derived maximum-likelihood method. When such considerations are incorporated, the optimal FBR technique leads to a new nonlinear imaging algorithm that implies adaptive formation of the second-order sufficient statistics of the data, their smoothing, and projection applying the composite regularizing window operator. We provide analytical techniques to find these statistics and windows, and the optimal FBR estimator itself. Numerical recipes, performance issues, and simulation examples are treated in a companion paper. [J165]

"Multiple hypothesis tracking for multiple target tracking"

Multiple hypothesis tracking (MHT) is generally accepted as the preferred method for solving the data association problem in modern multiple target tracking (MTT) systems. This paper summarizes the motivations for MHT, the basic principles behind MHT and the alternative implementations in common use. It discusses the manner in which the multiple data association hypotheses formed by MHT can be combined with multiple filter models, such as used by the interacting multiple model (IMM) method. An overview of the studies that show the advantages of MHT over the conventional single hypothesis approach is given. Important current applications and areas of future research and development for MHT are discussed. [J166]

"Efficient frequency offset resolution for OFDM systems based on ML principle"

The main disadvantage of OFDM systems is its sensitivity to carrier frequency offset (CFO) and timing offset. In this paper, an efficient method for estimating CFO is developed based on maximum likelihood principle, of which emphasis on the CFO ambiguity resolution. In this method, only one training symbol is required and the range of the CFO that can be handled is the overall transmission spectrum. Differential coding in frequency-domain is performed to estimate the integral part of CFO (IFO). When frequency-selective channel is present, prior information of the statistic of the channel frequency response is used to eliminate its effect on estimation performance. Computer simulations are performed to show the superiority to the method available. [J167]

"antenna-pattern correction for near-field-to-far field RCS transformation of 1D linear SAR measurements"

In a previous AMTA paper (B. E. Fischer, et al.), we presented a first-principles algorithm, called wavenumber migration (WM), for estimating a target's far-field RCS and/or far-field images from extreme near-field linear

(one-dimensional) or planar (two-dimensional) SAR measurements, such as those collected for flight-line diagnostics of aircraft signatures. However, the algorithm assumes the radar antenna has a uniform, isotropic pattern for both transmitting and receiving. In this paper, we describe a modification to the (one-dimensional) linear SAR wavenumber migration algorithm that compensates for nonuniform antenna-pattern effects. We also introduce two variants to the algorithm that eliminate certain computational steps and lead to more efficient implementations. The effectiveness of the pattern compensation is demonstrated for all three versions of the algorithm in both the RCS and the image domains using simulated data from arrays of simple point scatterers. [J168]

"Error analysis of the moment method"

Because of the widespread use of the Method of Moments for simulation of radiation and scattering problems, analysis and control of solution error is a significant concern in computational electromagnetics. The physical problem to be solved, its mesh representation, and the numerical method all impact accuracy. Although empirical approaches such as benchmarking are used almost exclusively in practice for code validation and accuracy assessment, a number of significant theoretical results have been obtained in recent years, including proofs of convergence and solution-error estimates. This work reviews fundamental concepts such as types of error measures, properties of the problem and numerical method that affect error, the optimality principle, and basic approximation error estimates. Analyses are given for surface-current and scattering-amplitude errors for several scatterers, including the effects of edge and corner singularities and quadrature error. We also review results on ill-conditioning due to resonance effects and the convergence rates of iterative linear-system solutions. [J169]

"Novel Doppler laser radar for diagnostics in fusion reactors"

We describe the development of a novel Doppler laser radar (DOLAR) for remote measurement of flow velocity (0-10m/s)and film thickness of liquid metal walls, currently being studied for their superior heat handling and self-healing characteristics. Small fluctuations in flow velocity(mm/s)and flow thickness (50mcm)that may arise during plasma discharges can also be measured. The DOLAR is also designed for non intrusive mapping of features of plasma-facing solid surfaces with very high precision (50mcm). It can also measure the motion of structural components of a fusion reactor during plasma discharges and during plasma disruptions. The device utilizes frequency modulation laser radar principles for precision range measurements. Compensation of Doppler frequency shift is used to measure flow velocity. The DOLAR probe head is designed with acousto-optic and piezoelectric devices for operation in the harsh fusion environment. [J170]

"Invariant-based probabilistic target tracking and identification with GMTI/HRR measurements"

An invariant-based algorithm is presented for ground moving-target tracking and identification using ground moving-target indicator and high-resolution range measurements. The algorithm effectively exploits coupled information between target kinematics and identification spaces by introducing the concept of local and global motion. A geometrical invariant constraint based on the target rigidity principle is built into target kinematics and measurement models, which facilitate joint information exploitation. An interacting multiple template algorithm is developed to tightly work with a traditional tracker for joint tracking and identification. Besides providing target kinematics behaviour and identity information, the algorithm is capable of reconstructing the prominent physical structure of a moving target. [J171]

"0.5-μm CMOS orthogonal encoding readout cell for active imaging systems"

We propose a novel continuous-time simultaneous-readout scheme for active imaging systems based on orthogonal modulation of photodetector signals. The superimposed-continuous-time approach presented here differs from the conventional scheduled-discrete-time scheme in that the photodetector signals are summed in a common bus and read concurrently. We show how that our proposed architecture may be advantageous, particularly in applications where bandwidth requirements for a time-multiplexed scheme are highly demanding. The active readout cell presented here is the kernel of the proposed orthogonal encoding architecture. We describe the cell operation principle, its properties and major design challenges. A 0.5-μm CMOS test chip has been fabricated to demonstrate functionality of the readout architecture. Test results show it to be a viable option for highly-integrated active imaging systems. [J172]

"Characterizing errors in airborne laser altimetry data to extract soil roughness"

Airborne laser altimetry has the potential to make frequent detailed observations that are important for many aspects of studying land surface processes. However, the uncertainties inherent in airborne laser altimetry data have rarely been well measured. Uncertainty is often specified as generally as 20 cm in elevation and 40 cm planimetric. To better constrain these uncertainties, we present an analysis of several datasets acquired

specifically to study the temporal consistency of laser altimetry data and, thus, assess its operational value. The error budget has three main components, each with a time regime. For measurements acquired less than 50 ms apart, elevations have a local standard deviation in height of 3.5 cm, enabling the local measurement of surface roughness of the order of 5 cm. Points acquired seconds apart acquire an additional random error due to differential geographic positioning system fluctuation. Measurements made up to an hour apart show an elevation drift of 7 cm over a half hour. Over months, this drift gives rise to a random elevation offset between swathes, with an average of 6.4 cm. The root mean square planimetric error in point location was derived as 37.4 cm. We conclude by considering the consequences of these uncertainties on the principle application of laser altimetry in the U.K. intertidal zone monitoring. [J173]

"Synthetic aperture Radar oil spill segmentation by stochastic complexity minimization"

We present a new algorithm for oil spill segmentation in synthetic aperture radar (SAR) images, using the minimum description length (MDL) principle and a polygonal active grid. This algorithm is based on two steps: a first partitioning step into homogeneous regions and a second classification step with an automatic MDL thresholding. The obtained method allows one to segment the different candidate oil spills in an image automatically and in a few seconds. [J174]

"Space-time autoregressive filtering for matched subspace STAP"

Practical space-time adaptive processing (STAP) implementations rely on reduced-dimension processing, using techniques such as principle components or partially adaptive filters. The dimension reduction not only decreases the computational load, it also reduces the sample support required for estimating the interference statistics. This results because the clutter covariance is implicitly assumed to possess a certain (nonparametric) structure. We demonstrate how imposing a parametric structure on the clutter and jamming can lead to a further reduction in both computation and secondary sample support. Our approach, referred to as space-time autoregressive (STAR) filtering, is applied in two steps: first, a structured subspace orthogonal to that in which the clutter and interference reside is found, and second, a detector matched to this subspace is used to determine whether or not a target is present. Using a realistic simulated data set for circular array STAP, we demonstrate that this approach achieves significantly lower signal-to-interference plus noise ratio (SINR) loss with a computational load that is less than that required by other popular approaches. The STAR algorithm also yields excellent performance with very small secondary sample support, a feature that is particularly attractive for applications involving nonstationary clutter. [J175]

"Electromagnetic scattering from an arbitrarily shaped three-dimensional homogeneous chiral body"

The method of moments technique for analyzing electromagnetic scattering from an arbitrarily shaped three-dimensional homogeneous chiral body is presented based on the combined field integral equations. The body is assumed to be illuminated by a plane wave. The surface equivalence principle is used to replace the body by equivalent electric and magnetic surface currents. These currents radiating in unbounded free space produce the correct scattered field outside. The negatives of these currents produce the correct total internal field, when radiating in an unbounded chiral medium. By enforcing the continuity of the tangential components of the total electric and magnetic fields on the surface of the body, a set of coupled integral equations is obtained for the equivalent surface currents. The surface of the body is modeled using triangular patches. The triangular rooftop vector expansion functions are used for both equivalent surface currents. The coefficients of these expansion functions are obtained using the method of moments. The mixed potential formulation for a chiral medium is developed and used to obtain explicit expressions for the electric and magnetic fields produced by surface currents. Numerical results for bistatic radar cross sections are presented for three chiral scatterers-a sphere, a finite circular cylinder, and a cube. [J176]

"Two-dimensional finite-difference modeling of media with inclined uniaxial conductivity with an equivalent biaxial conductivity tensor for homogeneous TM-type wave propagation problems"

The principle of numerically modeling the surface impedance of a homogeneous transverse magnetic (TM)-type plane wave incident upon an inhomogeneous half-space with inclined uniaxial electrical anisotropy as an equivalent half-space with fundamental electrical biaxial anisotropy is demonstrated. The self-consistent impedance method is introduced and shown to accurately model the surface impedance response of these two-dimensional (2-D) induction problems at low frequencies relevant to surface impedance geophysics, though there is inaccuracy in the surface impedance phase as the frequency is increased. While the impedance method has been introduced to demonstrate this modeling concept, the modeling principles introduced can be applied to other 2-D numerical methods. [J177]

"Methods and examples for remote sensing data assimilation in land surface process modeling"

Land surface process models describe the energy, water, carbon, and nutrient fluxes on a local to regional scale using a set of environmental land surface parameters and variables. They need time series of spatially distributed inputs to account for the large spatial and temporal variability of land surface processes. In principle many of these inputs can be derived through remote sensing using both optical and microwave sensors. New approaches in four-dimensional data-assimilation (4DDA) form the basis to combine remote sensing data and spatially explicit land surface process models more effectively. This paper describes basic techniques for 4DDA in land surface process modeling. Two case studies were carried out to demonstrate different successful approaches of remote sensing data assimilation into land surface process models. The assimilation of surface soil moisture estimates from European Remote Sensing (ERS) synthetic aperture radar data in a flood forecasting scheme is presented, as well as the combination of a land surface process model and a radiative transfer model to improve the accuracy of land surface parameter retrieval from optical data [Landsat Thematic Mapper (TM)]. [J178]

"Electromagnetics-the uncertain health risks"

Considering all the evidences to date in the scientific literature, an association between EM fields at the environmental levels and harmful effects to human is inconclusive or uncertain. However, the available evidences are enough to raise concern by certain segments of the public. In order to manage health risk in the face of scientific uncertainty, authorities may be persuaded to consider precautionary approaches while establishing safety standards and protection guidelines for EM fields. The precautionary principle is another management tool that could be adopted to deal with the health risks associated with EM exposure. It is an extremely conservative decision making principle that leads to prudent actions in the face of uncertainty. Where there is reasonable risk to the public, a prudent action to reduce the risk should be carried out. This procedure should hold even when the scientific proof is inconclusive as long, as the balance of quantitative and qualitative risk, benefit and cost of action justifies it. [J179]

"CFAR detection of multidimensional signals: an invariant approach"

The paper deals with constant false alarm rate (CFAR) detection of multidimensional signals embedded in Gaussian noise with unknown covariance. We attack the problem by resorting to the principle of invariance,which proves a valuable statistical tool for ensuring a priori, namely at the design stage, the CFAR property. In this context, we determine a maximal invariant statistic with respect to a proper group of transformations that leave unaltered the hypothesis-testing problem under study, devise the optimum invariant detector, and show that no uniformly most powerful invariant (UMPI) test exists. Thus, we establish the conditions an invariant detector must fulfill in order to ensure the CFAR property. Finally, we discuss several suboptimal (implementable) invariant receivers and, remarkably, show that the generalized likelihood ratio test (GLRT) detector is a member of this class. The performance analysis, which has been carried out in the presence of a Gaussian signal array, shows that the proposed detectors exhibit a quite acceptable loss with respect to the optimum Neyman-Pearson detector. [J180]

"Physics-based detection of targets in SAR imagery using support vector machines"

Radar scattering from an illuminated object is often highly dependent on the target-sensor orientation. In conjunction with physics based feature extraction, the exploitation of aspect-dependent information has led to successful improvements in the detection of tactical targets in synthetic aperture radar (SAR) imagery. While prior work has attempted to design detectors by matching them to images from a training set, the generalization capability of these detectors beyond the training database can be significantly improved by using the principle of structural risk minimization. In this paper, we propose a detector based on support vector machines that explicitly incorporates this principle in its design, yielding improved detection performance. We also introduce a probabilistic feature-parsing scheme that improves the robustness of detection using features obtained from a two-dimensional matching-pursuits feature extractor. Performance is assessed by considering the detection of tactical targets concealed in foliage, using measured foliage-penetrating SAR data. [J181]

"Principles of radar and sonar signal processing [JBook Review]"

First Page of the Article [J182]

"Digital beamforming in SAR systems"

The rapid progression in digital hardware and signal processing capabilities stimulates the development of radar systems. The tendency is to move the digital interface toward the antenna, replacing, whenever possible, analog

RF-hardware. Based on software codes, these digital systems are more flexible and easier to reconfigure than RF-hardware. This letter illustrates the general concept for digital beamforming (DBF) in synthetic aperture radar systems and investigates their principle capabilities, limitations, and performance parameters. It is shown that using DBF a simultaneous improvement in azimuth coverage and resolution can be achieved. [J183]

"Ten questions on UWB [Jultra wide band radar]"

Most radars now in use are narrow band systems with frequency bands much less than the carrier frequency. The theory and practice of current radar systems are based of this specific feature. But as is known, it is the frequency band that determines the information content of radar systems, as the volume of information transmitted per time unit is directly proportional to the frequency band. To raise the information capability of a radar system, the widening of its frequency band is needed. The only alternative approach is an increase in information transmission time. The actuality of this problem has determined rapid development in the last years of technologies using ultra wide band (UWB) signals. This paper describes the principles and features of UWB radar. [J184]

"Early quasioptics of near-millimeter and submillimeter waves in IRE-Kharkov, Ukraine: from ideas to the microwave pioneer award"

This paper is about the early quasioptics of near-millimeter and submillimeter waves in IRE-Kharkov (Institute of Radio Physics and Electronics of the National Academy of Sciences of Ukraine) and the development of the hollow dielectric beam-waveguide (HDB) technology and measuring techniques of the near-millimeter and submillimeter wavelength ranges, with main application in hot plasma diagnostics. It presents the details of the development based on the declassified reports and the interviews of Y.M. Kuleshov and another key member of the quasioptics (QO) team, M. S. Yanovski. Y.M. Kuleshov and his team had already accumulated rich experience in developing waveguide measuring devices in the whole millimeter-wave range between 1954 and 1961. In 1994-1996, the research project "Ozero" was carried out with Y.M. Kuleshov as a principal investigator. The aim of the "Ozero" was to explore the feasibility of developing a kit of HDB-based measuring devices in the wavelength range λ = 0.7 to 1.7 mm. After the finish of "Ozero", in 1968-1971, the next R&D project called "Oliva" was granted by the same directorate of MRI. Its idea was to dwell on and refine the polarization principles in the measuring circuits for λ = 0.5-0.8 mm. HDB was patented only in 1969. Since the 1970s, the activities of the QO department were focused entirely on the development of HDB-based instruments and systems. Here, the major application area was hot plasma diagnostics in new large Tokamaks. They also dwelled in the development of the measuring techniques including reflectometry and polarimetry. Other HDB based systems elaborated in IRE include radars in the 1970-1980s and RCS testing ranges in the 1990s. [J185]

"A review of electromagnetic scattering analysis for inlets, cavities, and open ducts"

This paper is a review of all methods that have been used in the literature for the solution of a very important and challenging set of problems, namely electromagnetic scattering from inlets, cavities, and open ducts. The techniques examined have been grouped together according to their fundamental principles, so that easy and direct comparisons among them are facilitated. The complexity and difficulty of the problems are clearly inferred from the very long list of references, which includes several very recent articles. The purpose of the paper is to highlight the advantages and limitations of the techniques invoked, draw useful conclusions, and trigger initiatives for future improved approaches to the topic. [J186]

"Efficient mobility management for vertical handoff between WWAN and WLAN"

As we move toward next-generation all-IP wireless networks, we are facing the integration of heterogeneous networks, such as WWAN and WLAN, where vertical handoff is required. In vertical handoff between WWAN and WLAN, mobile hosts should be able to move freely across different networks while satisfying QoS requirements for a variety of applications. In order to achieve seamless handoff and maintain continuity of connection, we propose a novel mobility. management system that integrates a connection manager to detect network condition changes in a timely and accurate manner, and a virtual connectivity manager that uses an end-to-end principle to maintain a connection without additional network infrastructure support. A prototype system was built to test the effectiveness of the proposed system. Experiments show that seamless roaming between WLAN and WWAN can be achieved, and much better performance can be obtained than with the traditional scheme. [J187]

"Perspectives and visions for future SAR systems"

It is shown how far new SAR techniques, technologies and system principles, which at present are under consideration or under development, respectively, will fulfil future user requirements. Starting from the status

quo, the expected development of future SAR techniques and technology is presented, leading to the vision of an autonomous, global reconnaissance and remote sensing system with integrated communication and positioning capability. This system will have central illuminators together with a synchronised fleet of both airborne and spaceborne receivers, which enable continuous availability with a nearly global coverage, and dedicated information transfer to specific users in real time. [J188]

"Cross-calibration of interferometric SAR data"

Generation of digital elevation models from interferometric synthetic aperture radar (SAR) data is a well established technique. Achieving a high geometric fidelity calls for a calibration accounting for inaccurate navigation data and system parameters as well as system imperfections. Fully automated calibration techniques are preferable, especially for operational mapping. The author presents one such technique, called cross-calibration. Though developed for single-pass interferometry, it may be applicable to multi-pass interferometry, too. Cross-calibration requires stability during mapping, but not necessarily from map to map. It is based on natural distributed targets for which no a priori knowledge is needed. In particular, no DEM is required as in calibration techniques based on dedicated calibration scenes. To achieve absolute calibration, i.e. elimination of a constant elevation offset, a single ground control point is often needed. The paper presents the principles and mathematics of the cross-calibration technique and illustrates its successful application to EMISAR data. [J189]

"Development of a retrodirective PARC for ALOS/PALSAR calibration"

Polarimetric radar calibration is a procedure that corrects the polarization distortion of a measured scattering matrix by referring to the scattering matrix of a known target. The present paper describes the principle, design, manufacture and measurement results of a novel retrodirective polarimetric active radar calibrator (PARC). It accommodates both the depolarization characteristic by using dual-polarized antennas and retrodirectivity with the Van Atta array concept simultaneously. The PARC was designed for Phased Array L-band SAR (PALSAR) calibration based on the proposed principle. It consists of a 6Ч6-element antenna array with a 1-m-square aperture and four amplifiers with a 20-dB gain. The whole array is divided into four 3Ч3-element subarrays to form a two-dimensional (2-D) Van Atta array. Retrodirectivity extends the angular width, where the radar cross section exceeds 35 dBm2, which is a preliminary design goal, to almost twice the width of a conventional array reflector of the same size. However, it should be noted that the present design needs at least four times as many amplifiers as a conventional fixed-beam array reflector to be capable of 2-D source tracking. A prototype model of the present retrodirective PARC is manufactured in the L-band to allow Advanced Land-Observation Satellite (ALOS)/PALSAR calibration. The results we obtained through measurement agree well with the theoretical predictions, and substantiate the premise behind the present design of the retrodirective PARC for polarimetric SAR calibration. [J190]

"A balanced FET FMCW radar transceiver with improved AM noise performance"

A balanced FET frequency-modulated continuous-wave radar transceiver designed to suppress AM noise is presented. The transceiver utilizes the same device for output power amplification as for down-conversion of the received signal, thereby avoiding the need for separation of these signals. This makes the transceiver suitable for integration in monolithic-microwave integrated-circuit technology. A test circuit operating at 10 GHz was designed. The AM noise suppression is characterized, as well as output power and noise performance. Comparison with an unbalanced transceiver using the same principle of operation shows an improvement of 20 dB in AM noise performance. The output power is 14 dBm at 7-dBm input power [J191]

"Realization of true-time delay lines based on acoustooptics"

A true-time optical delay line for short radiofrequency (RF) pulses using path length dispersion is proposed. It is an optical implementation of the linear phase-shift theorem of the Fourier transformation. Acoustooptic signal processing is used for conversion into the optical frequency domain and for spatial Fourier decomposition of the pulse. The processing of the pulse is obtained by differentially phase shifting the particular frequency components, followed by a heterodyne reconversion into the RF domain. The optical system is intended to be used for delaying, but also for shaping and filtering of RF pulses, mainly in phased array radar antennas. Theoretical analysis of the system principle is given together with experimental results, demonstrating 2-μs time delay of 0.5-μs-long pulses with maximum optical phase shift of 1.2pi. A detailed theoretical and experimental bandwidth analysis is carried out, pointing to the main technical problems and their solutions [J192]

"Principles of space-time array processing for ultrawide-band impulse radar and radio communications"

The emerging ultrawide-band (UWB) impulse technology has found numerous applications in the commercial as well as the military sector. The rapid technological advances have made it possible to implement (cost-effective, short-range) impulse radar and impulse-radio communication and localization systems. Array beamforming and space-time processing techniques promise further advancement in the operational capabilities of impulse radar and impulse-radio communications to achieve long-range coverage, high capacity and interference-free quality of reception. We introduce a realistic signal model for UWB impulse waveforms and develop the principles of space-time array processing based on the signal model. A space-time resolution function (STRF), a space-frequency distribution function (SFDF) and a monopulse-tracking signal are derived for impulse waveforms received by a self-steering array beamforming system. The directivity peak-power pattern and energy pattern of the beamformer are also derived. Computer plots of the STRF, SFDF and the beam patterns are obtained. The directivity beam patterns of impulse waveforms are sidelobe-free and, therefore, there is no need for sidelobe suppression via amplitude weighting of the array elements. Also, the resolution angle for the beam patterns is derived as a decreasing function of array size and frequency bandwidth. Electronic beamsteering based on slope processing of monopulse waveforms is described [J193]

"US Air Force EarthRadar for detection and discrimination of buried unexploded ordnance"

The US Air Force EarthRadar system is a multi-purpose sensor designed and constructed using "radar" principles. This technology was originally developed for the US Air Force to detect buried unexploded ordnance (UXO). Bakhtar Associates developed the US Air Force EarthRadar technology under the DoD SBIR program. The system is capable of detecting buried metallic and non-metallic objects, including glass vials. In addition, the manner in which system hardware, signal processing, and the integrated high resolution global positioning system (GPS) are configured makes it ideal for applications such as mapping subsurface geological features, locating cavities and collapse features, and identifying contaminated ground [J194]

"Noisy echo detection using microwave correlation radiometry"

A random signal system dedicated to echo detection and location is described. Using the correlation radiometry principle, this system provides the ability to locate a mismatched discontinuity inserted in a TEM cell. Extension to short-range applications, such as level gauging, anticollision radar, mine detection, or the field of telecommunications, such as multipath propagation description, can also be considered. Experimental results provide a time resolution better than 0.1 ns when operating with a 2 GHz bandwidth system centred on 3 GHz [J195]

"Subpixel variability of remotely sensed soil moisture: an inter-comparison study of SAR and ESTAR"

The representation of subpixel variability in soil moisture estimates from passive microwave data was investigated through sensitivity analysis and by comparison against the spatial structure of soil moisture fields derived from radar data. This work shows that the subpixel variability not represented in brightness temperature fields is directly associated with the spatial organization of soil hydraulic properties and the spatial distribution of vegetation. The significant implication of this result is that the physical connection between soil moisture estimates at the pixel scale and local values within the pixel weakens strongly as the sensor resolution decreases. Subsequently, the application of scaling and fractal interpolation principles to downscale passive microwave data to the spatial resolution of radar data was investigated as a means to recover spatial structure. In particular, ESTAR soil moisture data was successfully downscaled from 200 to 40 m using only one radar frequency (e.g., L-band). This application suggests that the combined use of active and passive single-band microwave remote-sensing of soil moisture is a viable approach to improve the spatial resolution of soil moisture remote-sensing [J196]

"Advanced digital processing for amplitude and range determination in optical RADAR systems [Jfusion reactor inspection]"

An amplitude modulated laser radar has been developed by the Italian Agency for New Technologies, Energy and the Environment (ENEA) for periodic in-vessel inspection in large fusion machines. The viewing system is based on a transceiving optical radar using a radio frequency (RF) modulated single-mode 840-nm wavelength laser beam. The sounding beam is transmitted through a coherent optical fiber to a probe, on the tip of which a focusing optics and suitable scanning system, using a silica prism, steers the laser beam in order to obtain a complete 3-D mapping of the in-vessel surface. This paper describes the digital signal processing system used to modulate the laser beam, as well as to measure both the amplitude of the backscattered laser beam and the phase difference between it and the modulation signal. This information, together with the information on the scanning system position, are acquired and then used by the visualization system to produce both 2-D and 3-D

images. The system is based on VME boards and directly acquires and processes in real-time three 79.5-MHz RF signals by using a digital receiver and four digital signal processors. The system principles, the mathematical algorithm, and the system architecture are described hereafter [J197]

"Imaging system for low-density plasma by heterodyne interferometer with fan beam microwave"

A microwave imaging system based on a heterodyne interferometer has been developed to measure the spatial distribution of the plasma density without introducing any direct disturbance to the plasma by employing a diode array scattering technique. The imaging system with the use of a fan beam microwave for a radar system demonstrates the principle of the technique by placing finite-size dielectric phantoms instead of the plasma between the horn antenna and the diode antenna array. Experimental results show that very good image of the objects can be reconstructed and the system is equivalent to popularly known multichannel imaging system. As a result, it is possible to make simple, low-cost, and compact microwave interferometer for measuring the spatial distribution of the plasma density. copyright 2002 American Institute of Physics. [J198]

"Adaptive RLS algorithm for blind source separation using a natural gradient"

By using the natural gradient on the Stiefel manifold to minimize a nonlinear principle component analysis criterion, this letter proposes a new adaptive recursive-least-squares (RLS) algorithm with prewhitening for blind source separation (BSS), which makes full use of the orthogonality constraint of the separating matrix. Simulations show that the new natural-gradient-based RLS algorithm has faster convergence than the existing least-mean-square algorithms and RLS algorithm for BSS. [J199]

"Comments on "A shaped reflector antenna for 60-GHz indoor wireless LAN access points" [Jand reply]"

The author comments that the shaped reflector antenna principles and theory of Smulders, Khusial and Herben (see ibid., vol.50, p.584-91, Mar.2001) are based on the papers described by Kumar (see Proc. Montech '86 IEEE Conference on Antennas and Communication, 1986, IEEE Cat. No. TH0156-0, Inst. Elect. Eng. Proc., vol.134, p.106-108, 1987 and Technology Symposium, 1990). These papers described the X-band, circularly polarized shaped beam telemetry antenna suitable for retransmitting the radar data back to an earth terminal. Smulders et al. have used the same principle, and similar types of radiation patterns are produced. However, two points are different in their paper: (1) the design frequency (60 GHz) and (2) the application of antenna for indoor wireless LAN access points. Therefore, they authors should have referenced Kumar's papers. Smulders et al. agree with Kumar's comments that reflector shaping is nothing new. However, we took into account diffraction effects (by applying the uniform theory of diffraction) whereas the shaping in the paper of Kumar is based on geometrical optics, only. We showed that according to our approach, a more smooth illumination function can be achieved and how the smoothing effect depends on the amount of edge illumination. We also showed in which way the spatial field deviation can be minimized and that this could save a few decibels in the link budget. [J200]

"Design and scan performance of large, probe-fed stacked microstrip patch arrays"

A strategy is presented on how to design large, direct-contact microstrip patch arrays with broad bandwidths and useful scanning ranges. It is shown that to maximize these characteristics the lower layer of a stacked patch configuration must have a relatively high dielectric constant, greater than 10 and the upper laminate must have a low dielectric constant value. Doing so yields bandwidths in excess of 25% over a scanning range of ±45° in the principle planes. Such arrays may be suitable for millimeter-wave systems such as collision avoidance radars and microcellular mobile communication base stations [J201]

"Design principles of broadband adaptive Salisbury screen absorber"

A mechanically adaptive Salisbury screen is used to show that an adaptive screen can circumvent the bandwidth/thickness limitations of passive thin materials. The electronic analogue of the mechanical screen is described and the impedance characteristics of the electronic adaptive elements determined for single and multi-adaptive layered configurations [J202]

"Novel opportunities for optical level gauging and 3D-imaging with the photoelectronic mixing device"

The novel photoelectronic mixing device (PMD) possesses a variety of unique characteristics that open up new fields for optical distance measurement technology. PMD devices for the first time allow the use of straightforward modulation and system concepts previously constrained to radar and ultrasonic systems. This

paper first reviews the PMD principle and then points out the differences between conventional optical systems and PMD systems. The requirements of two different applications, level gauging, and three-dimensional object position measurement are discussed. Suitable system concepts are introduced and verified with experiments. The results prove the feasibility of single-pixel sensors capable of high accuracy and multitarget resolution as well as low-cost three-dimensional imaging systems. [J203]

"On the feasibility of a Doppler weather radar for estimates of drop size distribution using two closely spaced frequencies"

Dual-frequency weather radar data can be gathered using a single broadband power amplifier and antenna for the purpose of estimating parameters of the hydrometeor size distribution. This is an attractive feature for observation platforms that are limited with respect to mass or available power. Whether useful properties of the scattering medium can be obtained from data of this type is the focus of the paper. Generally, as the center frequency or the bandwidth is decreased, the reflectivity factor difference falls below the level of the inherent signal fluctuations. Even if large numbers of independent samples can be gathered to permit estimates of the differential signals, the question remains as to whether the signal can be related unambiguously to properties of the rain or snow. Center frequencies at or near 35 GHz with bandwidths in excess of 5% give relatively strong differential signals. The signal, moreover, is directly related to the median mass diameter of the size distribution. The differential mean Doppler at frequencies where non-Rayleigh scattering effects are significant is also of use because the quantity depends only on the terminal velocity of the drops and is insensitive to the mean air and platform motion. In principle, the mean and differential mean Doppler velocities from a nadir-viewing radar can be used to estimate the mean vertical air motion and the median drop diameter of the size distribution [J204]

"Dual polarization stacked microstrip patch antenna array with very low cross-polarization"

This paper describes the development and performance of a wideband dual linear polarization microstrip antenna array used in the Danish high-resolution airborne multifrequency polarimetric synthetic aperture radar, EMISAR. The antenna was designed for an operating frequency of 1.25 GHz±50 MHz and was built as an array of 8Ч2 probe-fed stacked microstrip patches. The feeding network is constructed in microstrip and is capable of handling 6 kW of peak input-power at an altitude of 45000 ft (unpressurized). The impedance bandwidth (return loss better than -14 dB) of the antenna is 10%, the isolation between the horizontal and the vertical ports of the array is 50 dB and the cross-polarization suppression is 40 dB. A new design principle for simultaneously achieving very low cross-polarization and low side lobes in dual linear polarization antenna arrays has been applied [J205]

"Mobility management incorporating fuzzy logic for heterogeneous a IP environment"

The next generation in mobility management will enable different mobile networks to interoperate with each other to ensure terminal and personal mobility and global portability of network services. However, in order to ensure global mobility, the deployment and integration of both satellite and terrestrial components are necessary. This article is focused on issues related to mobility management in a future mobile communications system, in a scenario where a multisegment access network is integrated into an IP core network by exploiting the principles of Mobile IP. In particular, attention is given to the requirements for location, address, and handover management. In a heterogeneous environment, the need to perform handover between access networks imposes particular constraints on the type of information available to the terminal and network. In this case, consideration will need to be given to parameters other than radio characteristics, such as achievable quality of service and user preference. This article proposes a new approach to handover management by applying the fuzzy logic concept to a heterogeneous environment. The article concludes with a presentation of mobility management signaling protocols [J206]

"Errors in bathymetric retrievals using linear dispersion in 3-D FFT analysis of marine radar ocean wave imagery"

The phenomenon of ocean wave-shoaling, and the associated reduction of ocean wave phase speed with decreased water depth, provides useful information for inferring water depth D (bathymetry) in coastal environments. One strategy for relating D to phase speed C and wave-vector K of long wavelength ocean waves involves using the one-dimensional (1-D) linear (gravity wave) dispersion relationship C 2=g*tanh(KD)/K. In principle, this approach has limitations because the approach is based on a WKB approximation, so it cannot be applied when D varies appreciably over the wavelength of a shoaling wave. Also, the approach is restricted to waves that have small wave height. The author uses a set of marine radar image sequences and applies this linear approximation, using a 3-D FFT analysis of 88 sets of image sequences spaced half an hour apart. The author inverts the dispersion relation to solve for D. Depths between 3.6 and 5.8 m were tested, for root mean

square (RMS) wave heights offshore between 8 and 3 m. The author shows that for low to moderate wave heights, the approach does generally retrieve the correct depth in water depths of 5 m and greater for moderate wave RMS heights. However, an increase in the RMS wave height from 1 m to 3.5 m produced a much poorer depth estimate, proving the need for an application of a nonlinear wave model to the problem. The errors also increase with shallower depths as expected, as the error dependence on depth and wave height is determined [J207]

"Recognition technology for the detection of buried land mines"

As described by Zadeh, recognition technology refers to systems that incorporate new sensors, novel signal processing, and soft computing. In this paper, we discuss these principles applied to the problem of land mine detection. We describe a complex recognition system that is evolving from basic research into a fielded system. Some components of this system have been field tested with excellent results, whereas other components have achieved such results in the laboratory. Fuzzy set-based information fusion algorithms are central to the excellent results obtained. Multiple-detection algorithms are applied to signals acquired from an innovative ground penetrating radar that produces volumetric sub-surface imagery. The outputs of the detection algorithms are combined using the fuzzy logic and Sugeno and Choquet fuzzy integrals to produce overall detection scores. Experimental results are provided on training data and on completely blind test data collected in the field and scored by the US Army [J208]

"Experimental model for a seismic landmine detection system"

A laboratory-scale experimental model has been developed and tested for a system that uses artificially generated high-frequency seismic waves in conjunction with a radar-based noncontact displacement sensor to detect buried landmines. The principle of operation of the system is to measure the transient displacement field very close to a mine location. In this way, the absorption and the geometrical spreading of the seismic waves have not reduced the effects of the mine. By using a seismic excitation, the system exploits the large difference between the elastic properties of a mine and the surrounding soil. This difference causes seismic wave interactions in the vicinity of a mine to be quite distinctive and provides a method for imaging mines and distinguishing them from typical buried clutter. Images of a variety of simulated and inert anti-tank and anti-personnel mines have been formed using this system. Burial scenarios involving natural clutter (rocks and sticks), light surface vegetation, localized burial effects, and multiple mines in close proximity have been studied. None of these scenarios appears to pose serious problems for detection performance [J209]

"Building the wireless Internet"

Everybody's talking about the wireless Internet, but what on earth is it? And who's building it? The trade press is adrift in a bewildering jumble of acronyms from the cellular telephony industry that claim to point the way. Or maybe dozens of LEOS (low-earth-orbiting satellites) will furnish the wireless Internet. Or perhaps it's really two way pagers on steroids-powered by WAP (the wireless access protocol). Proceeding from first principles, the author believes that none of the well-known technologies will, in the end, provide the wireless Internet. Instead a dark-horse technology-a “pure Internet” system based on technology familiar from a multitude of wireless local-area networks (LANs)-has good grounds to prevail. The author discusses which RF frequency bands should be used for the Internet, the use of nanocells to build the network, and gives a brief outline of the economics involved [J210]

"The hybrid extended Born approximation and CG-FFT method for electromagnetic induction problems"

The authors propose the hybridization of the extended Born approximation (EBA) with the conjugate-gradient fast Fourier transform (CG-FFT) method to improve the efficiency of numerical solution of electromagnetic induction problems. This combination improves the solution efficiency in two ways. First, using the FFT in the extended Born approximation decreases the computational cost of the conventional EBA method from O(N2) to O(N log2N) arithmetic operations, where N is the number of unknowns in the problem. This approach, referred to as the FFT-EBA method, applies to problems with a fairly large contrast. Secondly, using the EBA as a partial preconditioner for the CG-FFT method increases the convergence speed of the conventional CG-FFT method. This second approach, referred to as the EBA-CGFFT method, is in principle applicable to all problems with a homogeneous background, but is particularly efficient for problems with a higher contrast. Numerical experiments suggest that the combination of these two methods is more accurate and more efficient for electromagnetic induction problems [J211]

"Feature-level and decision-level fusion of noncoincidently sampled sensors for land mine

detection"

We present and compare methods for feature-level (predetection) and decision-level (postdetection) fusion of multisensor data. This study emphasizes fusion techniques that are suitable for noncommensurate data sampled at noncoincident points. Decision-level fusion is most convenient for such data, but it is suboptimal in principle, since targets not detected by all sensors will not obtain the full benefits of fusion. A novel algorithm for feature-level fusion of noncommensurate, noncoincidently sampled data is described, in which a model is fitted to the sensor data and the model parameters are used as features. Formulations for both feature-level and decision-level fusion are described, along with some practical simplifications. A closed-form expression is available for feature-level fusion of normally distributed data and this expression is used with simulated data to study requirements for sample position accuracy in multisensor data. The performance of feature-level and decision-level fusion algorithms are compared for experimental data acquired by a metal detector, a ground-penetrating radar, and an infrared camera at a challenging test site containing surrogate mines. It is found that fusion of binary decisions does not perform significantly better than the best available sensor. The performance of feature-level fusion is significantly better than the individual sensors, as is decision-level fusion when detection confidence information is also available (“soft-decision” fusion) [J212]

"Comparison of GLR and invariant detectors under structured clutter covariance"

This paper addresses a target detection problem in radar imaging for which the covariance matrix of unknown Gaussian clutter has block diagonal structure. This block diagonal structure is the consequence of a target lying along a boundary between two statistically independent clutter regions. Here, we design adaptive detection algorithms using both the generalized likelihood ratio (GLR) and the invariance principles. There has been considerable interest in applying invariant hypothesis testing as an alternative to the GLR test. This interest has been motivated by several attractive properties of invariant tests including: exact robustness to variation of nuisance parameters and possible finite-sample min-max optimality. However, in our deep-hide target detection problem, there are regimes for which neither the GLR nor the invariant tests uniformly outperforms the other. We discuss the relative advantages of GLR and invariance procedures in the context of this radar imaging and target detection application [J213]

"Time-frequency approaches to ISAR imaging of maneuvering targets and their limitations"

Inverse synthetic aperture radar (ISAR) imaging of the noncooperative maneuvering target is a challenging task because of its time variant orientation and rotation velocity which cannot be measured accurately. This correspondence investigates the principles of ISAR imaging of maneuvering targets, and proposes an algorithm for application in situations where the maneuverability is not too severe and the Doppler variation of subechoes from scatterers can be approximated as a first-order polynomial. The imaging results obtained by using real data show the effectiveness of the new method [J214]

"Intrusion location capability added to synergistic radar technology"

There is a new trend in the outdoor security market that demands more precision in identifying the crossing area of an intruder. Often called intrusion location capability, this capability also presents inherent features such as more accuracy in camera pre-set positioning and temporary disabling of sub-zone and individual sensitivity level per sub-zone. However even though market trend demands them, such features must have minimum impact to overall system cost. How the synergistic radar technology can be modified to offer intruder location capability to a sub-zone area as precise as 10% of the total zone length is presented. For a typical zone length of 100 meters, the zone is sub-divided into up to ten equally spaced sub-zones of 10 meters each, giving an intrusion crossing point resolution of 10 meters. Synergistic radar technology can be applied to buried, surface, wall and roof applications. This intrusion location capability also applies to each of these applications [J215]

"Sea-clutter modeling using a radial-basis-function neural network"

Recently, neural networks have been proposed for radar clutter modeling because of the inherent nonlinearity of clutter signals. This paper performs an analysis of the practicality of using a radial basis function (RBF) neural network to model sea clutter and to detect small target embedded in sea clutter. An experiment using an instrumental quality radar was carried out on the eastcoast of Canada to create a rich sea clutter and small surface target database. This database contains both staring and scanning data under various environmental conditions. Using data-sets with different characteristics, we investigate the effects of quantization error, measurement noise, generalization of the neural net over ranges and sampling rate on the RBF clutter model. Despite these physical limitations, the RBF model was shown to approach an optimal predictive performance. The RBF predictor was also applied to detect various small targets in this database based on the constant false alarm rate (CFAR) principle. This RBF-CFAR detector was demonstrated to be able to detect small floating

targets even in rough sea conditions [J216]

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