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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 47-1

“Advanced Radar Systems”
(«Современные РЛ системы»)

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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 47-1

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Журнальные публикации

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

We used advanced ground-penetrating radar (GPR) inversion techniques for detecting landmines in laboratory conditions. The radar data were acquired with a calibrated vector network analyzer combined with an off-ground monostatic horn antenna, thereby setting up a stepped-frequency continuous-wave radar. Major antenna effects and interactions with the soil and targets were filtered out using frequency-dependent complex antenna transfer functions. The proposed strategy first exploits inversion approaches that are able to give an accurate characterization of the antenna-soil interaction and a reliable estimate of the soil permittivity. The outcomes of this first phase are at the basis of the application of a microwave tomographic approach based on the Born approximation to achieve the imaging of the subsurface. The algorithms were applied for imaging three landmines of different sizes and buried at different depths in sand. Although the radar system was off the ground, the results showed that it was possible to reconstruct all mines, including a shallow plastic mine as small as 5.6 cm in diameter. This last mine was invisible in the raw radar data, and the use of common GPR imaging techniques did not lead to satisfactory results. The proposed integrated method shows great promise for shallow subsurface imaging in a demining context, particularly because it automatically provides accurate information on the shallow soil dielectric permittivity. [J1]

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

The signal processing of the medium-Earth-orbit synthetic aperture radar (SAR) is more challenging than that of the current low-Earth-orbit SAR because the imaging geometry is more complicated, and the range and azimuth variances are more severe. This paper deals with these imaging problems in three aspects. First, an advanced hyperbolic range equation (AHRE) is proposed for the first time, which is more precise for a spaceborne SAR than the conventional hyperbolic range equation (CHRE). Second, the point target spectrum based on the AHRE is analytically derived, which is useful for developing efficient SAR processing algorithms. Third, the well-known nonlinear chirp scaling (NLCS) algorithm is modified according to this new spectrum, and the so-called AHRE-based advanced NLCS (A-NLCS) algorithm is established. The simulation results validate the correctness of our method for L-band SAR systems at altitudes from 1000 to 10000 km with an azimuth resolution around 3 m. It is also shown that the A-NLCS algorithm has better performance than the CHRE-based algorithms in longer integration time cases. Therefore, we recommend the A-NLCS algorithm for a spaceborne SAR with a lower frequency, finer resolution, and higher satellite altitude. [J2]

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

Snow is a critical component of the global water cycle and climate system, and a major source of water supply in many parts of the world. There is a lack of spatially distributed information on the accumulation of snow on land surfaces, glaciers, lake ice, and sea ice. Satellite missions for systematic and global snow observations will be essential to improve the representation of the cryosphere in climate models and to advance the knowledge and prediction of the water cycle variability and changes that depend on snow and ice resources. This paper describes the scientific drivers and technical approach of the proposed Cold Regions Hydrology High-Resolution Observatory (CoReH2O) satellite mission for snow and cold land processes. The sensor is a synthetic aperture radar operating at 17.2 and 9.6 GHz, VV and VH polarizations. The dual-frequency and dual-polarization design enables the decomposition of the scattering signal for retrieving snow mass and other physical properties of snow and ice. [J3]

"UK airborne AESA radar research"

This reviews current UK airborne active electronically scanned array (AESA) designs, discusses current trends toward higher digitisation and multi-function aperture concepts, and details key future challenges that this technology faces. Specifically, we discuss applications to fast-jets. Key requirements are for higher levels of

digitisation to provide the performance required in ECCM, STAP, GMTI, and ESM modes. Building radar systems with the key basic building blocks to, as a minimum, enable future realisation of these advanced modes will help to Г‚Вїfuture proofГ‚Вї the systems. This design philosophy is integral to the concept of through life capability management (TLCM); Le., a system designed to support the ability to sustain capability through incremental, spiral upgrades of signal processing, line replaceable items (LRIs), firmware, and advanced modes. [J4]

"Identification and analysis of sea radar clutter spikes"

In recent times, considerable advances have been made on analysing low grazing angle radar sea clutter in the gigahertz frequency range. In this work, a set of coherent and polarimetric sea clutter data is analysed focusing on the statistical and spectral properties of the spikes, whatever is the physical phenomenon that generates them. Using three sea spike defining parameters, the spike amplitude, the minimum spike width and the minimum interval between spikes, it is possible to identify the spiking events from the background. This work shows a sample of results from a statistical and spectral analysis of a set of sea spikes selected from the radar returns, focusing on their Doppler properties, the spike duration and the temporal interval between spikes. [J5]

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

The Advanced Synthetic Aperture Radar (ASAR) Global Monitoring (GM) mode offers an opportunity for global soil moisture (SM) monitoring at much finer spatial resolution than that provided by the currently operational Advanced Microwave Scanning Radiometer for the Earth Observing System and future planned missions such as Soil Moisture and Ocean Salinity and Soil Moisture Active Passive. Considering the difficulties in modeling the complex soil-vegetation scattering mechanisms and the great need of ancillary data for microwave backscatter SM inversion, algorithms based on temporal change are currently the best method to examine SM variability. This paper evaluates the spatial sensitivity of the ASAR GM surface SM product derived using the temporal change detection methodology developed by the Vienna University of Technology. This evaluation is made for an area in southeastern Australia using data from the National Airborne Field Experiment 2005. The spatial evaluation is made using three different types of SM data (station, field, and airborne) across several different scales (1-25 km). Results confirmed the expected better agreement when using point (Rstation= 0.75) data as compared to spatial (RPLMR, 1 km= 0.4) data. While the aircraft-ASAR GM correlation values at 1-km resolution were low, they significantly improved when averaged to 5 km (RPLMR, 5 km= 0.67) or coarser. Consequently, this assessment shows the ASAR GM potential for monitoring SM when averaged to a spatial resolution of at least 5 km. [J6]

"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. [J7]

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

We report about the first X-band spaceborne-airborne bistatic synthetic aperture radar (SAR) experiment,

conducted early November 2007, using the German satellite TerraSAR-X as transmitter and the German Aerospace Center's (DLR) new airborne radar system F-SAR as receiver. The importance of the experiment resides in both its pioneering character and its potential to serve as a test bed for the validation of nonstationary bistatic acquisitions, novel calibration and synchronization algorithms, and advanced imaging techniques. Due to the independent operation of the transmitter and receiver, an accurate synchronization procedure was needed during processing to make high-resolution imaging feasible. Precise phase-preserving bistatic focusing can only be achieved if time and phase synchronization exist. The synchronization approach, based on the evaluation of the range histories of several reference targets, was verified through a separate analysis of the range and Doppler contributions. After successful synchronization, nonstationary focusing was performed using a bistatic backprojection algorithm. During the campaign, stand-alone TerraSAR-X monostatic as well as interoperated TerraSAR-X/F-SAR bistatic data sets were recorded. As expected, the bistatic image shows a space-variant behavior in spatial resolution and in signal-to-noise ratio. Due to the selected configuration, the bistatic image outperforms its monostatic counterpart in almost the complete imaged scene. A detailed comparison between monostatic and bistatic images is given, illustrating the complementarity of both measurements in terms of backscatter and Doppler information. The results are of fundamental importance for the development of future nonsynchronized bistatic SAR systems. [J8]

"Multi-Instrument Calibration Method Based on a Multiwavelength Ocean Surface Model"

A-Train platforms offer the possibility of measuring the same physical parameters using active and passive instruments, to improve our understanding of geophysical processes in the Earth system. In this letter, a new calibration approach is developed using active [Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) lidar and CloudSat radar] and passive [Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E)] instruments. The parameters of an existing oceanic surface model are first adjusted to give consistent sea surface scattering properties for CALIPSO and CloudSat observations. Revisiting the lidar/radar data analysis procedure using this model, as well as sea surface wind speed, the temperature and water vapor products of the microwave radiometer (AMSR-E) allowed one to refine the calibration factors for both lidar and radar observations in a coherent approach. This study also improves other applications such as the retrieval of atmospheric attenuation from aerosols at optical wavelengths. [J9]

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

Radar sensors with dual-polarization capability allow a better understanding and characterization of weather hazards, particularly hydrometeor particles. The knowledge of natural polarimetric hydrometeor scattering signatures, on the other hand, has been limited in theoretical calculations, simulations, and radar measurements. In this paper, an experimental approach was designed with the assistance of a controlled laboratory environment. An advanced vector network analyzer-based scatterometer system has been developed in harmony with an environmentally monitored anechoic chamber with special configurations for hydrometeor measurements. The polarimetric radar cross section (RCS) of various natural and man-made icy hydrometeor samples is measured across wide X-band frequencies and compared with theoretical modeling results. The dual-polarization radar variables and hydrometeor melting parameters are derived from the RCS measurements with interesting observations obtained. The described technology and results serve as the basis of a new hydrometer microphysics knowledge base for hydrometeor classification processing in the next-generation multichannel dual-polarized hazard monitoring radars. [J10]

"An Electronic Circuit System for Time-Reversal of Ultra-Wideband Short Impulses Based on Frequency-Domain Approach"

In this paper, a compact and low-cost electronic circuit system is designed for time-reversal of ultra-wideband short impulses (with nanosecond and sub-nanosecond temporal durations). A frequency-domain approach is adopted to avoid high sampling rate in time. Specifically, the proposed system obtains the discrete spectra of input impulses first; then realizes time-reversal in frequency domain; and finally synthesizes the time-reversed impulses using discrete continuous wave elements. This system is composed of common and commercially available circuits, and hence, can embody a system-on-chip implementation. Its performance is verified by circuit-electromagnetic co-simulations using impulses with 3-10-GHz frequency band coverage. Advanced Design System and two full-wave Maxwell's equations solvers are used for circuit and electromagnetic simulations, respectively, and their results are coupled and integrated. In the circuit part, most of nonidealities of realistic circuits are taken into account. It is shown by the simulation results that, although realistic circuits unavoidably introduce errors to time-reversal, such errors do not affect the ??focusing?? phenomena in the context of electromagnetic wave propagation. As a conclusion, the proposed system can be deployed in practical time-reversal communication and radar applications. [J11]

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

This paper describes a novel driver-support system that helps to maintain the correct speed and headway (distance) with respect to lane curvature and other vehicles ahead. The system has been developed as part of the Integrating Project PReVENT under the European Framework Programme 6, which is named SAfe SPEed and safe distaNCE (SASPENCE). The application uses a detailed description of the situation ahead of the vehicle. Many sensors [radar, video camera, Global Positioning System (GPS) and accelerometers, digital maps, and vehicle-to-vehicle wireless local area network (WLAN) connections] are used, and state-of-the-art data fusion provides a model of the environment. The system then computes a feasible maneuver and compares it with the driver's behavior to detect possible mistakes. The warning strategies are based on this comparison. The system "talks" to the driver mainly via a haptic pedal or seat belt and "listens" to the driver mainly via the vehicle acceleration. This kind of operation, i.e., the comparison between what the system thinks is possible and what the driver appears to be doing, and the consequent dialog can be regarded as simple implementations of the rider-horse metaphor (H-metaphor). The system has been tested in several situations (driving simulator, hardware in the loop, and real road tests). Objective and subjective data have been collected, revealing good acceptance and effectiveness, particularly in awakening distracted drivers. The system intervenes only when a problem is actually detected in the headway and/or speed (approaching curves or objects) and has been shown to cause prompt reactions and significant speed correction before getting into really dangerous situations. [J12]

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

This paper presents an application of the recent advances in the field of spherically invariant random vector (SIRV) modeling for coherency matrix estimation in heterogeneous clutter. The complete description of the polarimetric synthetic aperture radar (POLSAR) data set is achieved by estimating the span and the normalized coherency independently. The normalized coherency describes the polarimetric diversity, while the span indicates the total received power. The main advantages of the proposed fixed-point (FP) estimator are that it does not require any a prioriinformation about the probability density function of the texture (or span) and that it can directly be applied on adaptive neighborhoods. Interesting results are obtained when coupling this FP estimator with an adaptive spatial support based on the scalar span information. Based on the SIRV model, a new maximum-likelihood distance measure is introduced for unsupervised POLSAR classification. The proposed method is tested with both simulated POLSAR data and airborne POLSAR images provided by the Radar Ae?? roporte?? Multi-Spectral d'Etude des Signatures system. Results of entropy/alpha/anisotropy decomposition, followed by unsupervised classification, allow discussing the use of the normalized coherency and the span as two separate descriptors of POLSAR data sets. [J13]

"Advanced Land Observing Satellite (ALOS) and Monitoring Global Environmental Change"

The Advanced Land Observing Satellite (ALOS) was developed for detailed observation of the Earth's surface and frequent monitoring of global environmental changes, using high-resolution optical (visible and near infrared push-broom) and active microwave sensors (L-band synthetic aperture radar). ALOS has four mission objectives: cartography, regional observations, disaster observations, and resource exploration. It has been operational since its launch in January 24, 2006, and is acquiring a large amount of land-surface data supported by the Ka-band intersatellite communication system that downlinks to ground receiving stations. A global systematic acquisition strategy is implemented for all three sensors to enable consistent data collection over all land areas on a repetitive basis. Through its three sensors, acquisition strategy, and communication infrastructure, the ALOS mission is aimed to contribute to monitoring water, carbon, and global climate change. In this paper, we describe ALOS and its contribution to global environmental monitoring. [J14]

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

Temporal decorrelation is one of the main limitations for recovering interseismic deformation along the San Andreas Fault system using interferometric synthetic aperture radar. To assess the improved correlation properties of L-band with respect to C-band, we analyzed L-band Advanced Land Observation Satellite (ALOS) interferograms with a range of temporal and spatial baselines over three vegetated areas in California and compared them with corresponding C-band European Remote Sensing Satellite (ERS) interferograms. Over the highly vegetated Northern California forests in the Coast Range area, ALOS remains remarkably well correlated over a 2-year period, whereas an ERS interferogram with a similar temporal and spatial baseline lost correlation. In Central California near Parkfield, we found a similar pattern in decorrelation behavior, which enabled the recovery of a fault creep and a local uplifting signal at L-band that was not apparent at C-band. In the Imperial

Valley in Southern California, both ALOS and ERS have low correlation over farmlands. ALOS has lower correlation over some sandy surfaces than ERS, probably due to low signal-to-noise ratio. In general, L-band interferograms with similar seasonal acquisitions have higher correlation than those with dissimilar season. For both L- and C-band, correlation over vegetated areas decreases with time for intervals less than 1 year and then remains relatively constant at longer time intervals. The decorrelation time for L-band is more than 2 years in the forest in California whereas that for C-band is less than 6 months. Overall, these results suggest that L-band interferograms will reveal near-fault interseismic deformation once sufficient data become available. [J15]

"Comparative study on joint data/pilot strategies for high sensitivity galileo E1 open service signal acquisition"

Global Navigation Satellite Systems (GNSS) with the ability to provide accurate positioning and timing information have become very important for many essential applications of both military and civil purposes. The upcoming European GNSS, Galileo system, foresees providing new advanced signals aiming to improve the receiver sensitivity. Towards the objective of a high sensitivity Galileo receiver architecture capable of operating anywhere at any time, the authors introduce possible joint data/pilot acquisition strategies to adapt with the problem of low received signal power in indoor environments. Analytical expressions as well as Monte Carlo simulations in indoor scenarios are presented to describe and prove the strategies improvement with respect to the conventional one currently operating inside GPS receivers. Additionally, based on the performance comparison among all the strategies, some applicable suggestions with respect to different operation modes are provided as the main contribution here. [J16]

"Synthesis of mesoscale numerical weather prediction and empirical site-specific radar clutter models"

A littoral clutter modelling approach that derives three-dimensional refractivity profiles from mesoscale numerical weather prediction (MSNWP), applies them to parabolic equation (PE) propagation models, and combines them with empirical surface clutter reflectivity models to generate a more realistic model of surface clutter, is described. The MSNWP model is COAMPS®, coupled atmospheric mesoscale numerical prediction system. This study updates a paper for the IEEE Radar Conference in 2008: overwater discrete clutter, oil rigs, have been added to the model; new model comparisons with recorded data have been executed; and an evaporative duct model was appended below the refractivity profiles Burk et al. developed the approach presented here (i.e. COAMPS® provides atmospheric data for propagation models, which in turn provide data for clutter models). The current work advances this technology into the littorals. It has been tested over many cases of atmospheric conditions in several geographic areas. This synthesis of MSNWP and radar clutter models can provide clutter and propagation forecasts for military planners, retroactive prediction of propagation for clutter test data analysis and realistic models for radar system design and performance analysis. [J17]

"Airport Surveillance Processing Chain for High Resolution Radar"

The paper focuses on the design of the digital processing chain of a surface movement radar (SMR) for airport traffic in the frame of A-SMGCS (advanced-surface movements guidance and control system); in order to reach, or exceed, the demanding requirements for the A-SMGCS surveillance function, special attention has to be paid to SMR processing, whose main functional blocks are the CFAR (constant false alarm rate) processor, the plot extractor, and the track-while-scan (TWS). A description of these processing functions, tailored to a noncoherent, high-resolution radar, and of their implementation is provided. The performance evaluation is accompanied by trials on recorded data, as obtained from a national research and development project called fast prototyping (FP) project (2001–2003) and its subsequent activities. The aim of the work presented here is to give a system view of the radar processing chain for high-resolution SMR, being rather different than standard surveillance radar. [J18]

"Photonic Probes and Advanced (Also Phaseless) Near-Field Far-Field Techniques"

We present innovative near-field test ranges, named compact-near-field (CNF) and very-near-field (VNF). These use photonic probes, and advanced near-field far-field (NFFF) transformations from amplitude and phase (complex) or phaseless measurements. The photonic probe allows AUT-probe distances of less than one wavelength. This drastically reduces test-range and scanner dimensions, improves the signal-to-clutter ratio and the signal-to-noise ratio, and reduces the scanning area and time. In both the cases of complex and phaseless measurements, the neat-field-to-far-field transformation problem is properly formulated to further improve the rejection of clutter, noise, and truncation error. The advantages of the compact-near-field and very-near-field test ranges are discussed and numerically analyzed. Experimental results are presented for both planar and cylindrical scanning geometries. [J19]

"A Wireless Soil Moisture Smart Sensor Web Using Physics-Based Optimal Control: Concept and Initial Demonstrations"

This paper introduces a new concept for a smart wireless sensor web technology for optimal measurements of surface-to-depth profiles of soil moisture using in-situ sensors. The objective of the technology, supported by the NASA Earth Science Technology Office Advanced Information Systems Technology program, is to enable a guided and adaptive sampling strategy for the in-situ sensor network to meet the measurement validation objectives of spaceborne soil moisture sensors. A potential application for this technology is the validation of products from the Soil Moisture Active/Passive (SMAP) mission. Spatially, the total variability in soil-moisture fields comes from variability in processes on various scales. Temporally, variability is caused by external forcings, landscape heterogeneity, and antecedent conditions. Installing a dense in-situ network to sample the field continuously in time for all ranges of variability is impractical. However, a sparser but smarter network with an optimized measurement schedule can provide the validation estimates by operating in a guided fashion with guidance from its own sparse measurements. The feedback and control take place in the context of a dynamic physics-based hydrologic and sensor modeling system. The overall design of the smart sensor web-including the control architecture, physics-based hydrologic and sensor models, and actuation and communication hardware-is presented in this paper. We also present results illustrating sensor scheduling and estimation strategies as well as initial numerical and field demonstrations of the sensor web concept. It is shown that the coordinated operation of sensors through the control policy results in substantial savings in resource usage. [J20]

"An Evaluation of the ALOS PALSAR L-Band Backscatter-Above Ground Biomass Relationship Queensland, Australia: Impacts of Surface Moisture Condition and Vegetation Structure"

Focusing on woody vegetation in Queensland, Australia, the study aimed to establish whether the relationship between Advanced Land Observing Satellite (ALOS) Phased Array L-band SAR (PALSAR) HH and HV backscattering coefficients and above ground biomass (AGB) was consistent within and between structural formations (forests, woodlands and open woodlands, including scrub). Across these formations, 2781 plot-based measurements (from 1139 sites) of tree diameters by species were collated, from which AGB was estimated using generic allometric equations. For Queensland, PALSAR fine beam dual (FBD) 50 m strip data for 2007 were provided through the Japanese Space Exploration Agency's (JAXA) Kyoto and Carbon (K&C) Initiative, with up to 3 acquisitions available for each Reference System for Planning (RSP) paths. When individual strips acquired over Queensland were combined, `banding' was evident within the resulting mosaics, with this attributed to enhanced L-band backscatter following rainfall events in some areas. Reference to Advanced Microwave Scanning Radiometer-EOS (AMSR-E) data indicated that strips with enhanced L-band backscatter corresponded to areas with increased effective vegetation water content (kg m-2) and, to a lesser extent, soil moisture (g cm-3). Regardless of moisture conditions, L-band HV topographically normalized backscattering intensities backscatter (σfo) increased asymptotically with AGB, with the saturation level being greatest for forests and least for open woodlands. However, under conditions of relative maximum surface moisture, L-band HV and HH σfowas enhanced by as much as 2.5 and 4.0 dB respectively, particularly for forests of lower AGB, with this resulting in an overall reduction in dynamic range. The saturation level also reduced at L-band HH for forests and woodlands but remained similar for open woodlands. Differences in the rate of increase in bo--th L-band HH and HV σfowith AGB were observed between forests and the woodland categories (for both relatively wet and dry conditions) with these attributed, in part, to differences in the size class distribution and stem density between non-remnant (secondary) forests and remnant woodlands of lower AGB. The study concludes that PALSAR data acquired when surface moisture and rainfall are minimal allow better estimation of the AGB of woody vegetation and that retrieval algorithms ideally need to consider differences in surface moisture conditions and vegetation structure. [J21]

"Angular Backscatter Variation in L-Band ALOS ScanSAR Images of Tropical Forest Areas"

Scanning synthetic aperture radar (ScanSAR) systems provide continuous information over large areas, but for effective use of such products in tropical forest, the decrease of radar backscatter with large variation of incidence angles requires attention. This letter analyzes the dependence of radar backscatter on incidence angle for L-band ScanSAR images of tropical forest. We investigated and modeled the angular backscatter effect per land-cover class in three ScanSAR images of the Colombian Orinoco. We found that there is an evident effect of incidence angle on radar backscatter, depending on land-cover class, moisture content, and physical structure of the reflecting targets. To normalize the angular backscatter variation, we proposed two methods. The first one applies a cosine correction estimated through linear regression. The second one models the radar backscatter of flooded forest considering second-order signal interactions. The model explains the observed backscatter of flooded forest areas in the rainy season (R2that is larger than 0.77). [J22]

"AESA upgrade option for Eurofighter Captor Radar"

The Euroradar Consortium has successfully developed and demonstrated an Active Electronically Scanned Array (AESA) technology upgrade for the Eurofighter Typhoon Captor Radar. This technology demonstrator, designated Captor Active Electronically Scanned Array Radar (CAESAR), enables E-scan capability to be fully exploited by the existing Captor radar, while retaining all features and capabilities of the original system. Advanced waveforms, designed and optimized for electronically-scanned radar systems, have been evaluated in recent CAESAR flight trials. Production of the CAESAR system will address repackaging of the AESA and associated components to minimize mass and volume, reduce cost, and ensure ease of supportability. CAESAR has demonstrated that AESA benefits can be provided within the existing Captor framework, enhancing sensor capability while retaining existing Eurofighter Typhoon interfaces. [J23]

"Feature Selection in AVHRR Ocean Satellite Images by Means of Filter Methods"

Automatic retrieval and interpretation of satellite images is critical for managing the enormous volume of environmental remote sensing data available today. It is particularly useful in oceanography and climate studies for examination of the spatio-temporal evolution of mesoscalar ocean structures appearing in the satellite images taken by visible, infrared, and radar sensors. This is because they change so quickly and several images of the same place can be acquired at different times within the same day. This paper describes the use of filter measures and the Bayesian networks to reduce the number of irrelevant features necessary for ocean structure recognition in satellite images, thereby improving the overall interpretation system performance and reducing the computational time. We present our results for the National Oceanographic and Atmospheric Administration satellite Advanced Very High Resolution Radiometer (AVHRR) images. We have automatically detected and located mesoscale ocean phenomena of interest in our study area (North-East Atlantic and the Mediterranean), such as upwellings, eddies, and island wakes, using an automatic selection methodology which reduces the features used for description by about 80%. Finally, Bayesian network classifiers are used to assess classification quality. Knowledge about these structures is represented with numeric and nonnumeric features. [J24]

"A 3-D X-Band T/R Module Package With an Anodized Aluminum Multilayer Substrate for Phased Array Radar Applications"

This paper presents the design and development of a compact 3-D transmit/receive (T/R) module with a selectively anodized aluminum multilayer package for X-band phased array radar applications. The proposed multilayer package consists of anodized aluminum substrates and vertical interconnects with embedded vias. The proposed package platform is based on thick anodized aluminum oxide layers and active bare chips directly mounted on bulk aluminum substrates for high electrical isolation and an effective heat sink. With its combination of thin-film embedded passive components and multilayer structure, the proposed module features a compact size of 20 mm Ч 20 mm, with a package height of 3.7 mm. To transfer radio-frequency (RF) signals vertically, we used coaxial hermetic seal vias with characteristic 50 Ω impedances and embedded anodized aluminum vias with a solder ball attachment and flip-chip bonding. The optimized vertical interconnect structure demonstrates RF characteristics with an insertion loss of less than 1.55 dB and a return loss of less than 12.25 dB over a broad bandwidth ranging from 0.1 to 10 GHz. The fabricated X-band 3-D T/R module has a maximum transmit output power of 39.81 dBm (9.5 W), a maximum transmit gain of 41.25 dB, and a receive gain of 19.15 dB over the 9-10 GHz frequency band. The RF-signal phase amplitude control is achieved by means of a 6 bit phase shifter with an rms accuracy of more than 5° and a gain setting range of 24 dB with an rms accuracy of more than 1.5 dB. The proposed multilayer aluminum package has the advantages of reducing the module size, decreasing the cost, and managing the thermal problem for X-band high-power T/R module package applications. [J25]

"Ballistic Projectile Tracking Using CW Doppler Radar"

The theory of operation is presented, together with experimental results, of a projectile target scoring system that determines highly accurate hit locations of small arms fire by processing constant frequency CW radar Doppler phase content into a trajectory estimate. We describe a new algorithm for extracting trajectory parameters from Doppler time series to obtain time, distance, and velocity at closest approach. Vector trajectories are derived by combining multiple scalar trajectories from three radar units. Live fire test results from a local range and Aberdeen Proving Ground are provided to show that a hit location accuracy of 4 cm can be achieved reliably on small arms. [J26]

"Predicting Small Target Detection Performance of Low-SNR Airborne Lidar"

Recent technological advances in the performance of small micro-lasers and multi-channel multi-event photo-detectors have enabled the development of experimental airborne lidar (light detection and ranging) systems based on a low-SNR (LSNR) paradigm. Due to dense point spacing (tens of points per square meter) and sub-decimeter range resolution, LSNR lidar can likely enable detection of meter-scale targets that would go unnoticed by traditional lidar technology. Small vehicle obstructions and other similar targets in the beach and littoral zones are of particular interest, because of LSNR lidar's applicability to the near-shore environment and the general desire to improve detection of antivehicle and antipersonnel obstacles in the coastal zone. A target detection procedure is presented that exploits the detailed information available from LSNR lidar data while diminishing the effect of spurious noise events. Consideration is given to detection in both topographic and bathymetric scenarios. Data sets for target detection analysis are supplied by a numerical sensor simulator developed at the University of Florida. Target detection performance is evaluated as a function of environmental characteristics, such as water clarity and depth, and system parameters, specifically transmitted pulse energy and laser pulse repetition frequency. Analysis of results with regards to consideration for future system design is discussed. [J27]

"Microwave Signature of the Greenland Ice Sheet at Ku- and S-Bands"

This letter is focused on the microwave signature characterization of the Greenland ice sheet. Such characterization is carried out by exploiting the S- and Ku-band brightness temperatures measured by the radar altimeter RA-2 when it operates as a radiometer during the ENVISAT Commissioning Phase for the purpose of calibrating the receiver. Despite the poor radiometric resolution and the calibration issues, this activity represented a unique opportunity to gather brightness temperatures at frequencies that are not available from current spaceborne microwave radiometers. The analysis of the passive RA-2 data investigates the influence of terrain height and of the temperature of the snow layers on the brightness temperatures at RA-2 bands. The effect of the different penetration depths of the electromagnetic radiation at S- and Ku-bands is also pointed out. Measurements from the Advanced Microwave Scanning Radiometer for the Earth Observing System are used to complement the data provided by RA-2 and to verify their reliability. [J28]

"Rain Observations by a Multifrequency Dual-Polarized Radiometer"

During the Convective and Orographically Induced Precipitation Study, advanced microwave radiometer for rain identification has continuously acquired measurements at the Atmospheric Radiation Measurement Mobile Facility in the Black Forest from the beginning of August until December 2007. The radiometer has six channels measuring in horizontal and vertical polarizations at 10.65, 21.0, and 36.5 GHz. Rainy events have been selected out of the entire database according to collocated gauges and, subsequently, analyzed. Measured brightness temperatures and (vertical-horizontal) polarization differences are interpreted by comparing with radiative transfer simulations, which account for the presence of nonspherical particles in preferential orientation. Measurements confirm the importance of the polarization signal for separating the effect introduced by non-Rayleigh scatterers and, therefore, the rain from the cloud component. More quantitative interpretation of the signal requires a better understanding of the role played by melting particles and an identification of the 3-D structure of the precipitating system under observation. Both aspects will be tackled in the near future by exploiting the synergy with a coinstalled micro rain radar. [J29]

"Assessment of Glacier Volume Change Using ASTER-Based Surface Matching of Historical Photography"

Glaciated regions are known to be particularly sensitive to climate change. Historical archives of glacier volume change are important, as they provide context for present-day changes. Although photogrammetric archives exist for many regions, their usefulness is often limited by a lack of contemporary ground control. High quality digital elevation models (DEMs) underpin a range of change analysis activities. This paper presents a cost-effective solution which utilizes Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) DEMs as control for the scaling and orientation of archival data sets. Instead of relying upon ground-control points, a robust surface matching algorithm is employed to automatically determine the transformation required to register two overlapping DEMs. Through application to the Slakbreen glacier system in Svalbard, Norway, the strategy is assessed by first matching an ASTER DEM to a fixed lidar reference surface. This demonstrates that ASTER DEMs are effectively correct in scale, supporting their use as a control surface. The second stage of the research implements this by matching an aerial photogrammetric DEM to an ASTER reference surface. Resultant volumetric and annual elevation change rates are compared to those derived from lidar data, which are considered in this paper as a truth data set. ASTER-based matching produced a mean annual elevation change rate of -4.12 ma-1, compared to a value of -4.11 ma-1derived from the lidar data. In volumetric terms, this equates to a difference of 0.6%. A major advantage of this approach is the near-global coverage offered by ASTER data and the opportunity that this presents for remote glacial change analysis over regional extents. [J30]

"Monitoring Sugarcane Growth Using ENVISAT ASAR Data"

The objective of this paper is to investigate potential of satellite C-band synthetic aperture radar (SAR) radar in monitoring sugarcane growth in southern China. This paper proposes a method to map sugarcane growing area and retrieve sugarcane leaf area index (LAI) in different growth stages using ENVISAT Advanced SAR (ASAR) alternating polarization HH/HV data. The temporal response of ASAR alternating polarization HH/HV data to sugarcane fields and sugarcane LAI was first analyzed in the study area. The analysis shows that sugarcane fields have increasing temporal radar response trend with sugarcane growth and ratio of ASAR HV to HH data has a better correlation with the increase of sugarcane LAI. A theoretical radiative transfer model was adopted to interpret the trend. Based on the temporal variation of the radar response of sugarcane fields, a method for mapping sugarcane planting area was developed using ASAR HH and HV polarization data at two acquisition dates with a certain classification accuracy. The empirical models were also established to estimate LAI of sugarcane using the HV/HH polarization ratio. The results suggest that C-band ASAR data appear promising in the development of an operational system for monitoring sugarcane growth in southern China. [J31]

"Special Issue on Remote Sensing of Building Interior"

The 15 papers in this special issue focus on remote sensing of building interior and can be categorized into: 1) system design and instrumentation; 2) advanced imaging techniques for elimination of glint from large flat wall structures; 3) radar polarimetry; 4) passive microwave radiometry; 5) advanced forward models based on high-frequency methods as well as full-wave solutions based on finite-difference time-domain technique for large-scale problems; and 6) detection and identification techniques of behind the wall stationary and moving concealed and unconcealed targets. [J32]

"CTBV Integrated Impulse Radio Design for Biomedical Applications"

Improving quality of service in wireless communication links is of vital importance in biomedical applications. Limitations of current technology are evident with a limited number of channels and prone to fading. In this paper, we are exploring impulse radio as a feasible technology for health monitoring and even as novel detached sensors. By exploring advanced deep submicron technology and novel architectures, improved quality of service may be granted. Additional interesting biomedical functionality of the impulse radio is detached body sensors (short-range medical radar). [J33]

"Predicting Topographic and Bathymetric Measurement Performance for Low-SNR Airborne Lidar"

Government and commercial airborne light detection and ranging (lidar) systems have enabled extensive measurements of the Earth's surface and land cover over the past decade. There is much interest, however, in employing smaller lidar systems that require less power to enable sensing from small unmanned aerial vehicles or satellites. Technological advances in the performance of small microlasers and photodetector sensitivity have recently enabled the development of experimental airborne lidar systems with low signal-to-noise ratios (LSNRs). Recent government and academic prototypes have indicated that LSNR airborne lidars could significantly increase the fidelity of terrain reconstruction over what is possible with existing conventional lidars. Thus, there is a need to build up a modeling capability for such systems in order to aid in future system and mission design. A numerical sensor simulator has been developed to model the expected returns from LSNR microlaser altimeter systems and predict their performance. Both optical and signal processing system components are considered, along with other factors, including atmospheric effects and surface conditions. Topographic (solid Earth) and bathymetric (littoral zone) measurement scenarios are considered. The analysis of topographic simulation data focuses on the effect of solar noise on SNR and elevation accuracy while bathymetric performance is evaluated with regard to water depth and scan angle for different water clarities. The mission conditions chiefly responsible for limiting the performance of LSNR lidar are discussed in detail, along with suggestions for further algorithm development and system performance evaluation. [J34]

"The GPS Contribution to the Error Budget of Surface Elevations Derived From Airborne LIDAR"

When using airborne LIDAR to produce digital elevation models, the global positioning system (GPS) positioning of the LIDAR instrument is often the limiting factor, with accuracies typically quoted as being 10-30 cm. However, a comprehensive analysis of the accuracy and precision of GPS positioning of aircraft over large temporal and spatial scales is lacking from the literature. Here, an assessment is made of the likely GPS contribution to the airborne LIDAR measurement error budget by analyzing more than 500 days of continuous GPS data over a range of baseline lengths (3-960 km) and elevation differences (400-2000 m). Height errors corresponding to the 95th percentile are <0.15 m when using algorithms commonly applied in commercial software over 3-km baselines. These errors increase to 0.25 m at 45 km and <0.5 m at 250 km. At aircraft

altitudes, relative heights are shown to be potentially biased by additional errors approaching 0.2 m, partly due to unmodeled tropospheric zenith total delay (ZTD). The application of advanced algorithms, including parameterization of the residual ZTD, gives error budgets that are largely constant despite baseline length and elevation differences. In this case, height errors corresponding to the 95th percentile are <0.22 m out to 960 km, and similar levels are shown for one randomly chosen day over a 2300-km baseline. [J35]

"Suitability and Limitations of ENVISAT ASAR for Monitoring Small Reservoirs in a Semiarid Area"

In semiarid regions, thousands of small reservoirs provide the rural population with water, but their storage volumes and hydrological impact are largely unknown. This paper analyzes the suitability of weather-independent radar satellite images for monitoring small reservoir surfaces. The surface areas of three reservoirs were extracted from 21 of 22 ENVISAT Advanced Synthetic Aperture Radar scenes, acquired bimonthly from June 2005 to August 2006. The reservoir surface areas were determined with a quasi-manual classification approach, as stringent classification rules often failed due to the spatial and temporal variability of the backscatter from the water. The land-water contrast is critical for the detection of water bodies. Additionally, wind has a significant impact on the classification results and affects the water surface and the backscattered radar signal (Bragg scattering) above a wind speed threshold of 2.6 mmiddots-1. The analysis of 15 months of wind speed data shows that, on 96% of the days, wind speeds were below the Bragg scattering criterion at the time of night time acquisitions, as opposed to 50% during the morning acquisition time. Night time acquisitions are strongly advisable over day time acquisitions due to lower wind interference. Over the year, radar images are most affected by wind during the onset of the rainy season (May and June). We conclude that radar and optical systems are complimentary. Radar is suitable during the rainy season but is affected by wind and lack of vegetation context during the dry season. [J36]

"Measurement of Ionospheric Faraday Rotation in Simulated and Real Spaceborne SAR Data"

The influence of the atmosphere on a frequency-modulated electromagnetic wave traversing the ionosphere is becoming increasingly important for recent and upcoming low-frequency and wide-bandwidth spaceborne synthetic aperture radar (SAR) systems. The ionized ionosphere induces Faraday rotation (FR) at these frequencies that affects radar polarimetry and causes signal path delays resulting in a reduced range resolution. The work at hand introduces a simulation model of SAR signals passing through the atmosphere, including both frequency-dependent FR and path delays. Based on simulation results from this model [proven with real Advanced Land Observing Satellite Phased Array L-band Synthetic Aperture Radar (PALSAR) data], estimation of FR in quad-polarized SAR data using the given approach is shown for raw, range-compressed, and focused radar images. Path delays and signal chirp bandwidth effects are considered. Investigations discuss the suitability of raw and compressed data versus combination of total electron content maps with the Earth's magnetic field for FR estimation and deduced from a large number of analyzed PALSAR data sets. [J37]

"Wheat Crop Mapping by Using ASAR AP Data"

The purpose of this paper is to assess the use of C-band HH/VV backscatter ratio for mapping winter wheat. This paper analyzes two temporal series of images acquired in 2006 and 2007 by the Advanced Synthetic Aperture Radar (ASAR) system in alternating polarization (AP) mode, over an agricultural site located in southern Italy. Results on test data show that classification accuracies between 75% and 80% can be achieved by using a single ASAR image, acquired during the peak of the wheat-growing season. To achieve accuracies close to 90%, a spatial averaging at field scale is necessary. [J38]

"Waveform-Agile Sensing and Processing [JFrom the Guest Editors]"

The focus of this special issue is the development of signal processing techniques that are able to take full advantage of advances in radar systems. Phased array radars and space-time adaptive processing illuminate the value of waveform diversity with respect to time, space, frequency, and polarization. [J39]

"Field programmable gate array-based design and realisation of automatic censored cell averaging constant false alarm rate detector based on ordered data variability"

The design and field programmable gate array (FPGA)-based realisation of automatic censored cell averaging (ACCA) constant false alarm rate (CFAR) detector based on ordered data variability (ODV) is discussed here. The ACCA-ODV CFAR algorithm has been recently proposed in the literature for detecting radar target in non-homogeneous background environments. The ACCA-ODV detector estimates the unknown background level by dynamically selecting a suitable set of ranked cells and doing successive hypothesis tests. The proposed detector does not require any prior information about the background environment. It uses the variability index statistic as a shape parameter to accept or reject the ordered cells under investigation. Recent advances in

FPGA technology and availability of sophisticated design tools have made it possible to realise the computation intensive ACCA-ODV detector in hardware, in a cost-effective way. The architecture is modular and has been implemented and tested on an Altera Stratix II FPGA using Quartus II software. The post place and route result show that the proposed design can operate at 100-MHz, the maximum clock frequency of the prototyping board and for this frequency the total processing time required to perform a single run is 0.21--s. This amounts to a speedup for the FPGA-based hardware implementation by a factor of -110 as compared to software-based implementation, which takes 23--s to perform the same operation. [J40]

"Monitoring of the Rice Cropping System in the Mekong Delta Using ENVISAT/ASAR Dual Polarization Data"

The rice cropping system in Asia is undergoing major changes to cope with increasing demography and changing climate, making rice monitoring a critical issue. Past studies have demonstrated the use of C-band synthetic aperture radar (SAR) data to map rice areas. The methods were based on the temporal change of intensity backscattering coefficient of vertically or horizontally co-polarized data (VV or HH). In this paper, we assess the use of the HH/VV polarization ratio derived from Advanced SAR (ASAR) data from ENVISAT data for the production of rice paddy maps. The approach is based on past knowledge on the polarization behavior of rice canopy, i.e., VV backscattering is much lower than HH during a large part of the rice season, due to the attenuation of the wave by the vertical structure of the plants. The methodology is developed for the Mekong Delta, Vietnam, where a complex cropping pattern is found (one to three crops of rice per year). The approach includes a statistical analysis of the HH/VV distributions of rice and non-rice classes at different dates. The analysis results confirm that HH/VV can be used as classifier and point out the need for relevant speckle filtering prior to classification. A classification method is developed and applied to single- and multidate data sets. The methods are tested at one district of the province of An Giang and extended to the whole province. Comparisons of the mapping results to geographic-information-system land-use data and official agricultural statistics show very good agreement. The method will be further applied to the entire Mekong Delta. [J41]

"A Hybrid Conditional Random Field for Estimating the Underlying Ground Surface From Airborne LiDAR Data"

Recent advances in airborne light detection and ranging (LiDAR) technology allow rapid and inexpensive generation of digital surface models (DSMs), 3-D point clouds of buildings, vegetations, cars, and natural terrain features over large regions. However, in many applications, such as flood modeling and landslide prediction, digital terrain models (DTMs), the topography of the bare-Earth surface, are needed. This paper introduces a novel machine learning approach to automatically extract DTMs from their corresponding DSMs. We first classify each point as being either ground or nonground, using supervised learning techniques applied to a variety of features. For the points which are classified as ground, we use the LiDAR measurements as an estimate of the surface height, but, for the nonground points, we have to interpolate between nearby values, which we do using a Gaussian random field. Since our model contains both discrete and continuous latent variables, and is a discriminative (rather than generative) probabilistic model, we call it a hybridconditionalrandomfield. We show that a Maximum aPosterioriestimate of the surface height can be efficiently estimated by using a variant of the Expectation Maximization algorithm. Experiments demonstrate that the accuracy of this learning-based approach outperforms the previous best systems, based on manually tuned heuristics. [J42]

"Vibration-induced PM and AM noise in microwave components"

The performance of microwave components is sensitive to vibrations to some extent. Aside from the resonator, microwave cables, and connectors, bandpass filters, mechanical phase shifters, and some nonlinear components are the most sensitive. The local oscillator is one of the prime performance-limiting components in microwave systems ranging from simple RF receivers to advanced radars. The increasing present and future demand for low acceleration sensitive oscillators, approaching 10-13/g, requires a reexamination of sensitivities of basic nonoscillatory building-block components under vibration. The purpose of this paper is to study the phase-modulation (PM) noise performance of an assortment of oscillatory and nonoscillatory microwave components under vibration at 10 GHz. We point out some challenges and provide suggestions for the accurate measurement of vibration sensitivity of these components. We also study the effect of vibration on the amplitude-modulation (AM) noise. [J43]

"Azimuth Phase Center Adaptation on Transmit for High-Resolution Wide-Swath SAR Imaging"

Synthetic aperture radar (SAR) systems with multiple receive channels allow for high-resolution wide-swath imaging thus overcoming a fundamental limitation of conventional single-aperture SAR. By using multiple apertures in azimuth, additional samples are received for each transmitted pulse. This allows for a reduced pulse

repetition frequency (PRF) thereby enabling a wider swath. However, a nonoptimum PRF is associated with a nonuniform sample spacing in azimuth and needs to be compensated by a multichannel reconstruction algorithm. For strong deviations from the optimum PRF, the inverse character of such an algorithm might result in a degraded performance. This can be overcome by an innovative advanced transmit antenna architecture which allows for a pulse-to-pulse shift of the phase center. Such an antenna enables the adaptive adjustment of the system's phase center positions to the respective PRF, thereby ensuring constant performance over a clearly extended PRF range. In particular, in combination with conventional multichannel processing strategies, this technique represents the next step toward a fully active multiple-input multiple-output (MIMO) SAR and has a great potential for future systems. [J44]

"Adaptive path planning for VTOL-UAVs"

This describes the development of path planning algorithms of a small unmanned four-rotor helicopter. A powerful simulation environment of the whole UAV system-including the characteristics of the important ranging sensors for collision avoidance was developed. This is essential for developing, testing, and verifying of the algorithms. Different collision avoidance strategies for VTOL-UAVs are presented. Enhancements and miniaturization will offer more powerful sensor technologies regarding size, range, and power in the future. Very promising are improvements of sensor modules and new technologies like three-dimensional LASER range-finder, PMD sensors, RADAR range-finder, and stereo camera tracking system. Because of the general high level simulation tool introduced herein they can be easily validated and tested without the need and effort of a real hardware implementation. The results showed that adaptive path planning, including collision avoidance, is already applicable on-board small UAV vehicles. With the mentioned new sensor technologies and more calculation power, further improvements like advanced collision notice and global path planning on-board small UAVs are attainable. [J45]

"The Impact of Multipath on High-Resolution SAS Image Statistics"

As with traditional sonar, synthetic aperture sonar (SAS) is susceptible to multipath contamination, reducing the quality and also modifying the statistics of the image. Such multipath contaminants may either be environmentally induced, as is often the case when attempting to image ranges greater than the water depth resulting in returns from the boundaries, or may be induced by the system's supporting structure itself. A clear understanding of such statistical impact is necessary to advance synthetic aperture formation algorithms and for predicting system performance. Broadband acoustic data suitable for SAS processing collected with a rail-mounted mobile-tower as part of the U.S. Office of Naval Research (ONR)-funded Sediment Acoustics eXperiment 2004 (SAX04) are analyzed in this paper. Analysis focused on both system structure and environmentally induced multipath using the K-distribution shape parameter as a metric. High-resolution sonar imagery often exhibited significantly non-Rayleigh, heavy-tailed envelope statistics, characterized by a low equivalent K-distribution shape parameter. Analysis showed a clear and significant increase in the estimated shape parameter in the presence of multipath, representing a trend toward a Rayleigh-distributed envelope. A model for reverberation is presented to provide bounds of the statistical impact using observable image intensity level increases in synthetic-aperture-formed images caused by multipath contamination. This model further shows potential for statistical impact when multipath arrivals are of similar level as the direct path even when not observable in the image (e.g., within 10 dB). [J46]

"Arctic sea ice mapping with satellite radars"

The drastic reduction of Arctic sea ice in recent years demands ice monitoring over various spatial and temporal scales. Sea ice backscatter signatures from field measurements and from model analyses are obtained at L-band and C-band frequencies. Based on these signatures, capabilities for Arctic sea ice mapping are determined for current and future satellite active microwave sensors including synthetic aperture radars (SAR) and scatterometers. This study includes L-band and C-band radars such as the ERS (European Remote Sensing), Envisat (Environmental Satellite), RADARSAT-1 and 2, ALOS (Advanced Land Observing Satellite), and DESDnyl (Deformation, Ecosystem Structure, and Dynamics of Ice). SARs with resolutions from 10 to 100 m, and the SMAP (Soil Moisture Active-Passive) scatterometer with resolutions from 1 to 10 km. [J47]

"Where next for airborne AESA technology?"

Airborne radar has evolved from early systems where almost all radar characteristics were fixed to today's highly flexible, software-driven systems. The most recent advance has been the widespread adoption of active electronically scanned array (AESA) antennas, which has given the system designer unprecendented control of antenna characteristics. However, in common with most conventional radars, even these systems only operate within a limited frequency band. This argues that the next major advance will be the advent of wideband and

multi-band systems, thus addressing the major remaining constraint facing the system designer and offering the capability for a step change in the functionality and performance of future systems. [J48]

"Verification of Polarimetric Calibration Method Including Faraday Rotation Compensation Using PALSAR Data"

The spaceborne Phased Array L-band Synthetic Aperture Radar (PALSAR) needs polarimetric calibration in order for PALSAR data to be utilized for various applications such as geophysical analysis. In case of a PALSAR system using L-band, the Faraday rotation (FR) effect, which rotates the polarization plane of radio waves, becomes a problem when full-polarimetric observation data are used, such as target classification using polarization synthesis. Therefore, we need to estimate and remove both antenna distortion matrices and the FR effect. In this paper, we propose a polarimetric calibration method taking both channel imbalance and crosstalk of receiving and transmitting antennas and FR effect into consideration using two reference reflectors, namely, polarization preserving reflector and polarization rotating one. Then, we apply our calibration method to PALSAR data and derive antenna distortion matrices and FR angle simultaneously. Our calibration results show that the estimated antenna distortion matrices are almost equal to the calibration results from the Japan Aerospace Exploration Agency and that the estimated FR angle has a reasonable value. [J49]

"Thermal-wave radar: A novel subsurface imaging modality with extended depth-resolution dynamic range"

Combining the ideas behind linear frequency modulated continuous wave radars and frequency domain photothermal radiometry (PTR), a novel PTR method is introduced. Analytical solutions to the heat diffusion problem for both opaque and transparent solids are provided. Simulations and experimental results suggest a significant improvement in the dynamic range when using the thermal-wave radar (TWR) instead of conventional PTR. A practical TWR image resolution augmentation method is proposed. [J50]

"Combining magnetic resonance imaging and ultrawideband radar: A new concept for multimodal biomedical imaging"

Due to the recent advances in ultrawideband (UWB) radar technologies, there has been widespread interest in the medical applications of this technology. We propose the multimodal combination of magnetic resonance (MR) and UWB radar for improved functional diagnosis and imaging. A demonstrator was established to prove the feasibility of the simultaneous acquisition of physiological events by magnetic resonance imaging and UWB radar. Furthermore, first in vivo experiments have been carried out, utilizing this new approach. Correlating the reconstructed UWB signals with physiological signatures acquired by simultaneous MR measurements, representing respiratory and myocardial displacements, gave encouraging results which can be improved by optimization of the MR data acquisition technique or the use of UWB antenna arrays to localize the motion in a focused area. [J51]

"Ensemble Kalman filter"

Meteorological models are used to predict the weather, study atmospheric processes, and provide input to decision makers on the consequences of increased greenhouse gas emissions to the Earth's climate. Predictions of future atmospheric states are accomplished as an initial value or marching problem, where the initial atmospheric state is specified and the variables are advanced in time using numerical techniques. The challenge of data assimilation in meteorology is to estimate, based on a set of limited observations of varying types, the complete three-dimensional atmospheric state at a given time to provide an initial value for a meteorological model. [J52]

"Aerosol Lidar Intercomparison in the Framework of SPALINET-The Spanish Lidar Network: Methodology and Results"

A group of eight Spanish lidars was formed in order to extend the European Aerosol Research Lidar Network-Advanced Sustainable Observation System (EARLINET-ASOS) project. This study presents intercomparisons at the hardware and software levels. Results of the system intercomparisons are based on range-square-corrected signals in cases where the lidars viewed the same atmospheres. Comparisons were also made for aerosol backscatter coefficients at 1064 nm (2 systems) and 532 nm (all systems), and for extinction coefficients at 532 nm (2 systems). In total, three field campaigns were carried out between 2006 and 2007. Comparisons were limited to the highest layer found before the free troposphere, i.e., either the atmospheric boundary layer or the aerosol layer just above it. Some groups did not pass the quality assurance criterion on the first attempt. Following modification and improvement to these systems, all systems met the quality criterion. The backscatter

algorithm intercomparison consisted of processing lidar signal profiles simulated for two types of atmospheric conditions. Three stages with increasing knowledge of the input parameters were considered. The results showed that all algorithms work well when all inputs are known. They also showed the necessity to perform, when possible, additional measurements to attain better estimation of the lidar ratio, which is the most critical unknown in the elastic lidar inversion. [J53]

"Comparison of the ASI Ice Concentration Algorithm With Landsat-7 ETM+ and SAR Imagery"

Continuous monitoring of sea ice and its changes is mainly done by passive microwave sensors on satellites. One frequently used technique of retrieving sea-ice concentrations is the Arctic Radiation and Turbulence Interaction STudy Sea Ice (ASI) algorithm, which uses the near-90-GHz channels, here those of the Advanced Microwave Scanning Radiometer-Earth Observing System to calculate sea-ice concentrations. The ASI ice concentrations are compared with ice concentrations derived from the following: 1) the multispectral imager Enhanced Thematic Mapper Plus operating on Landsat and 2) from Envisat and Radarsat SAR images. In this paper, we focus on marginal ice zones, as the ice concentrations in those regions are in general observed with higher errors. First-year ice (bias: -1%-0% and rms error: 1%-4%) and young ice (bias: -4%-0% and rms error: 3%-9%) are fairly well recognized with little underestimation of ASI ice concentrations with respect to Landsat ice concentrations. New ice is identified with less accuracy by the ASI algorithm (bias: -16%-9% and rms error: 18.3%-26.2%). Averaged over all ice types, the bias ranges between -8.4% and 4.5%, and the rms error ranges between 2.0% and 17.4%. Discrepancies mainly occur in polynya areas (underestimation by ASI) and along the ice edge (overestimation by ASI). The results of the ASI-SAR comparison yield contrasting results. ASI underestimates the ice concentrations near the ice edge but overestimates them in some interior areas (bias: -2.9%-2.5% and rms error: 16.9%-20.1%). The discrepancies between both comparisons may be due to the different interaction mechanisms of the different sensor types, particularly with the newly formed ice. [J54]

"Fast-switching system for injection seeding of a high-power Ti:sapphire laser"

A high frequency switching and tunable seed laser system has been designed and constructed for injection seeding of a high-power pulsed Ti:sapphire laser. The whole laser system operates as the transmitter of a scanning, ground-based, water-vapor differential absorption lidar (DIAL). The output of two seed lasers can be tuned in the wavelength range of 815-840 nm up to the power of 20 mW and switched between the online and offline wavelengths of the DIAL at frequencies of 0-1 kHz. The frequency stability of online and offline seed lasers is better than ±20 MHz rms and the mode-hop-free tuning range is greater than 40 GHz with external cavity diode lasers. The advantage of this system for efficient injection seeding of the Ti:sapphire cavity is that it is modular, robust, fully fiber-coupled, and polarization maintaining. [J55]

"Three-dimensional automatic mesh generation for hybrid electromagnetic simulations"

Hybrid mesh generation is required for finite-difference time-domain/finite-element time-domain (FDTD/FETD) hybrid simulations. A combined approach is presented to automatically generate Cartesian/tetrahedral hybrid meshes for open and closed structures. This approach first generates a buffer zone that surrounds a target with specified tightness. The advancing-front technique with ldquosweep-and-retryrdquo is subsequently applied to generate an initial tetrahedral mesh that fills the buffer zone. Finally, the tetrahedral mesh undergoes a combined quality improvement procedure. Due to the low profile of the resulting tetrahedral mesh, the sparse Cholesky decomposition can be applied effectively to solve the resulting FETD matrix. Several examples are provided to demonstrate the main features and the performance of the proposed automatic mesh-generation method. [J56]

"Latest trends in radar system testing"

Radar systems were initially limited to military applications, but today most people encounter radar applications everyday. Given the broad range of applications, a variety of radar types and technologies have emerged to meet unique needs. This paper discusses about the latest advances on system performance and testing of radar systems. When performing characterization of a radar receiver design, a variety of signals are required to accurately recreate the operational environment. This paper will review the test signal environment needed for evaluation of various modern radar systems. Performance considerations in terms of signal source fidelity and spectral purity will also be investigated. [J57]

"The Hunt For The Kill Switch"

This paper has described the issues on electronic circuits which are made for military equipments.The DoD of U.S. recently launched its most ambitious program yet to verify the integrity of the electronics that will underpin future additions to its arsenal. The Defense Advanced Research Projects Agency (DARPA), the Pentagon's R&D

wing, and released details about a three-year initiative it calls the Trust in Integrated Circuits program. The findings from the program could give the military and defense contractors who make sensitive microelectronics like the weapons systems for the F-35 a guaranteed method of determining whether their chips have been compromised. The Trust program started its prequalifying rounds by sending to three contractors four identical versions of a chip that contained unspecified malicious circuitry, though U.S. military consumes only 1% of world's integrated circuits. [J58]

"Autonomous vehicle development: No accident"

The Insight Racing team in Cary, North Carolina, began turning a bright-blue Lotus Elise into a driverless vehicle that could compete in a robotic car race. The mission of DARPApsilas ldquoGrand Challengerdquo, the Defense Advanced Research Projects Agency, part of the U.S. Department of Defense, is to develop technology with military applications. When, in 2001, Congress mandated that at least a third of all military vehicles be autonomous by 2015, the agency responded with a series of races, all with million-dollar prizes and open to anyone who could build a driverless robotic car. AnnieWay's car, silver VW Passat, was equipped with LIDAR (light detection and ranging) sensors that can find obstacles around the car, look for curbs and depressions in the road, and detect whether the vehicle is going uphill or downhill. The AnnieWay robotic car made it to the finals of the Urban Challenge where it competed for US$3.5 million in cash prizes. The AnnieWay's Passat was custom made so that it could switch between manual and autonomous driving. [J59]

"Sparse Representation in Structured Dictionaries With Application to Synthetic Aperture Radar"

Sparse signal representations and approximations from overcomplete dictionaries have become an invaluable tool recently. In this paper, we develop a new, heuristic, graph-structured, sparse signal representation algorithm for overcomplete dictionaries that can be decomposed into subdictionaries and whose dictionary elements can be arranged in a hierarchy. Around this algorithm, we construct a methodology for advanced image formation in wide-angle synthetic aperture radar (SAR), defining an approach for joint anisotropy characterization and image formation. Additionally, we develop a coordinate descent method for jointly optimizing a parameterized dictionary and recovering a sparse representation using that dictionary. The motivation is to characterize a phenomenon in wide-angle SAR that has not been given much attention before: migratory scattering centers, i.e., scatterers whose apparent spatial location depends on aspect angle. Finally, we address the topic of recovering solutions that are sparse in more than one objective domain by introducing a suitable sparsifying cost function. We encode geometric objectives into SAR image formation through sparsity in two domains, including the normal parameter space of the Hough transform. [J60]

"Signal Synthesis and Receiver Design for MIMO Radar Imaging"

Multiple-input-multiple-output (MIMO) radar is an emerging technology that has significant potential for advancing the state-of-the-art of modern radar. When orthogonal waveforms are transmitted, with M+N(Ntransmit and Mreceive) antennas, an MN-element filled virtual array can be obtained. To successfully utilize such an array for high-resolution MIMO radar imaging, constant-modulus transmit signal synthesis and optimal receive filter design play critical roles. We present in this paper a computationally attractive cyclic optimization algorithm for the synthesis of constant-modulus transmit signals with good auto- and cross-correlation properties. Then we go on to discuss the use of an instrumental variables approach to design receive filters that can be used to minimize the impact of scatterers in nearby range bins on the received signals from the range bin of interest (the so-called range compression problem). Finally, we present a number of numerical examples to demonstrate the effectiveness of the proposed approaches. [J61]

"Fiber lasers: A future technology for lasers in space"

The constraints of operation in space have largely precluded the use of conventional solid-state laser systems for applications including remote sensing, communication relays, and active laser radars. A new technology, fiber lasers, may offer all of the needed features at an affordable price. An appealing aspect of the fiber laser is that it does not need a rigid optical bench. Only the output end of the fiber need be held in rigid reference to the optical tracking system. Design, fabrication, and testing of the laser resonator is generally the most expensive and longest lead part of the effort for conventional solid-state lasers. Advances in fiber optic technology and devices mean that the "fiber laser" need not be a simple device but may be a complex system employing sophisticated technology, such as wavelength selective Bragg reflectors and nonlinear optical frequency shifters. Three companies have obtained single-mode outputs of 35-40 watts single mode at 1.03-1.1 mu. [J62]

"Quickest Detection and Tracking of Spawning Targets Using Monopulse Radar Channel Signals"

Recent advances have been reported in detecting and estimating the location of more than one target within a

single monopulse radar beam. Successful tracking of those targets has been achieved with the aid of nonlinear filters that approximate the targets' states' conditional pdf, bypassing the measurement extraction stage, and operating directly on the monopulse sum/difference data, i.e., without measurement extraction. The problem of detecting a target spawn will be tackled in this paper. Particle filters will be employed as nonlinear tracking filters to approximate the posterior probability densities of the targets' states under different hypotheses of the number of targets, which in turn can be used to evaluate the likelihood ratio between two different hypotheses at subsequent time steps. Ultimately, a quickest detection procedure based on sequential processing of the likelihood ratios will be used to decide on a change in the underlying target model as an indication of a newly spawning target. Radar signal processing, data association, and target tracking are handled simultaneously. [J63]

"Using C-Band Synthetic Aperture Radar Data to Monitor Forested Wetland Hydrology in Maryland's Coastal Plain, USA"

Hydrology (i.e., inundation and soil moisture) is the most important abiotic factor controlling wetland function and extent, and scientists predict that wetland hydrology can be significantly altered over relatively short timescales due to climate change and anthropogenic impact. Whereas broadscale hydrology is difficult to monitor in forested wetlands with ground-based and optical remote sensing methods, C-band synthetic aperture radar (SAR) systems have the potential to improve the capability to monitor forested wetland hydrology. In this study, we examined the use of Environmental Satellite Advanced SAR (C-HH and C-VV) data for monitoring levels of inundation and soil moisture throughout the year in a typical Mid-Atlantic floodplain and some of the main limitations inherent to C-band data (i.e., polarization and plant phenology) in this environment. The relationships between the backscatter coefficient and inundation, soil moisture, tree basal area, tree height, and forest canopy closure were examined. Significant differences in C-HH were found between forested areas of varying hydrology (0%-60% area inundated) throughout the year and in C-VV during the leaf-off season. As expected, C-HH SAR backscatter was better correlated with inundation and soil moisture than was C-VV SAR backscatter, and the correlations between both polarizations of backscatter and hydrology were stronger during the leaf-off season (C-HH leaf-off, leaf-on ; C-VV leaf-off, leaf-on ; all significant at level). Based on our findings, we concluded that the C-HH data are useful for monitoring hydrology beneath forest canopies throughout the year, whereas the C-VV data can be used during the leaf-off season. Our findings support previous studies that concluded that C-band imagery can be used to monitor forested wetland hydrology in large floodplains that are fully inundated. However, this study used detailed in situ measurements and demonstrated that C-band SAR data can also be used to monitor-forested wetland hydrology in smaller partially inundated floodplains, which are more common in the Mid-Atlantic. [J64]

"Estimation of the Temporal Evolution of the Deformation Using Airborne Differential SAR Interferometry"

This paper presents airborne differential synthetic aperture radar (SAR) interferometry results using a stack of 14 images, which were acquired by the Experimental SAR system of the German Aerospace Center (DLR) during a time span of 2.5 h. An advanced differential technique is used to retrieve the error in the digital elevation model and the temporal evolution of the deformation for every coherent pixel in the image. The two main limitations in airborne SAR processing are analyzed, namely, the existence of residual motion errors (RMEs) (inaccuracies in the navigation system on the order of 1-5 cm) and the accommodation of the topography and the aperture dependence on motion errors during the processing. The coupling between them is also addressed, showing that the estimation of the differential RME, i.e., baseline error, can be biased when using techniques based on the coregistration between interferometric looks. The SAR focusing chain to process the data is also presented together with the modifications in the differential interferometry processor to deal with the remaining baseline error. The detected motion of a corner reflector and the measured deformation in several agricultural fields allows one to validate the proposed techniques. [J65]

"Fusion of Hyperspectral and LIDAR Remote Sensing Data for Classification of Complex Forest Areas"

In this paper, we propose an analysis on the joint effect of hyperspectral and light detection and ranging (LIDAR) data for the classification of complex forest areas. In greater detail, we present: 1) an advanced system for the joint use of hyperspectral and LIDAR data in complex classification problems; 2) an investigation on the effectiveness of the very promising support vector machines (SVMs) and Gaussian maximum likelihood with leave-one-out-covariance algorithm classifiers for the analysis of complex forest scenarios characterized from a high number of species in a multisource framework; and 3) an analysis on the effectiveness of different LIDAR returns and channels (elevation and intensity) for increasing the classification accuracy obtained with hyperspectral images, particularly in relation to the discrimination of very similar classes. Several experiments carried out on a complex forest area in Italy provide interesting conclusions on the effectiveness and

potentialities of the joint use of hyperspectral and LIDAR data and on the accuracy of the different classification techniques analyzed in the proposed system. In particular, the elevation channel of the first LIDAR return was very effective for the separation of species with similar spectral signatures but different mean heights, and the SVM classifier proved to be very robust and accurate in the exploitation of the considered multisource data. [J66]

"Neuroinspired Architecture for Robust Classifier Fusion of Multisensor Imagery"

Two new algorithms for robust and fault-tolerant classifier combination are presented. The attractor dynamics (AD) algorithm models some properties of sensory integration in the central nervous system and is based on the application of the dynamical systems for classifier fusion. The classifier masking (CM) algorithm is a nonneural version of the AD algorithm based on finding intersecting classifier intervals. Both of the proposed algorithms employ the idea of consensus among individual classifiers. The individual classifiers have been trained using resampled feature sets. They fuse the information from advanced synthetic aperture radar, medium resolution imaging spectrometer, and advanced along track scanning radiometer envisat satellite sensors for the improved sea ice classification. The results of our experiments show that training and combing the individual classifier outputs in a multiple classifier system significantly improve the robustness and the fault tolerance of the classification system as compared to the single classifier combining all sources of information. The robustness of the single classifier has been largely reduced in cases of single sensor failures (87.9 % in normal conditions versus 64.8% and 66.1% for two artificially corrupted data sets), whereas the CM algorithm is more tolerant to the sensor and preprocessing errors (86.4% in normal conditions versus 78.9% and 73.6% for two artificially corrupted data sets). The performance of the CM algorithm is superior to those of the simple multiple classifier combination strategies based on classifier averaging and majority voting (78.9% versus 70.9% and 69.5%, respectively) because the AD and CM algorithms are able to discard the corrupted classifier outputs based on classifier agreement and, in fact, represent hybrid approaches combining the properties of classifier averaging and classifier selection methods. [J67]

"Advances in bistatic radar (Willis, N.J. and Griffiths, H.D., Eds.; 2007) [JBook Review]"

The editors have collected a comprehensive set of monographs that provide insight into the more recent history of bistatic radar design and implementation. This volume combines improved details of the environment along with novel system applications. Each chapter is authored by radar experts who had the vision and motivation to tackle a daunting development problem, and share their view of the successes and remaining implementation challenges. The book is divided into two parts: Bistatic/Multistatic Systems and Bistatic Clutter and Signal Processing. The book is an essential addition to the modern radar engineer's library. [J68]

"Scatterometer-Derived Soil Moisture Calibrated for Soil Texture With a One-Dimensional Water-Flow Model"

Current global satellite scatterometer-based soil moisture retrieval algorithms do not take soil characteristics into account. In this paper, the characteristic time length of the soil water index has been calibrated for ten sampling frequencies and for different soil conductivity associated with 12 soil texture classes. The calibration experiment was independently performed from satellite observations. The reference soil moisture data set was created with a 1-D water-flow model and by making use of precipitation measurements. The soil water index was simulated by applying the algorithm to the modeled soil moisture of the upper few centimeters. The resulting optimized characteristic time lengths Tincrease with longer sampling periods. For instance, a Tof 7 days was found for sandy soil when a sampling period of 1 day was applied, whereas an optimized T-value of 18 days was found for a sampling period of 10 days. A maximum rmse improvement of 0.5% vol. can be expected when using the calibrated T-values instead of T= 20. The soil water index and the differentiated T-values were applied to European Remote Sensing (ERS) satellite scatterometer data and were validated against insitusoil moisture measurements. The results obtained using calibrated T-values and T= 20 did not differ (r= 0.39, rmse = 5.4% vol.) and can be explained by the averaged sampling period of 4-5 days. The soil water index obtained with current operational microwave sensors [Advanced Wind Scatterometer (ASCAT) and Advanced Microwave Scanning Radiometer-Earth Observation System] and future sensors (Soil Moisture and Ocean Salinity and Soil Moisture Active Passive) should benefit from soil texture differentiation, as they can record on a daily basis either individually or synergistically using several sensors. The proposed differentiated characteristic time length enables the continuation of the soil water index of sen--sors with varying sampling periods (e.g., ERS-ASCAT). [J69]

"Post WWII technology [JPart Two, NASA at 50]"

The US space program is a prime example of how a national imperative can reap benefits far beyond its initial goals. The attraction of space had been unfolding for nearly a century in novels; and early experiments with

balloons and aircraft stimulated interest across the globe. Advances in rocket propulsion and structures were absolutely vital to accessing outer space; it is unlikely that the space race could have proceeded without these two critical technologies. Although discovered in the late 1 940 s, solid-state electronics remained a curiosity until the military began to use them to reduce the size, weight, and power requirements for their critical systems. [J70]

"Accuracy and Resolution of ALOS Interferometry: Vector Deformation Maps of the Father's Day Intrusion at Kilauea"

We assess the spatial resolution and phase noise of interferograms made from L-band Advanced Land Observing Satellite (ALOS) synthetic-aperture-radar (SAR) data and compare these results with corresponding C-band measurements from European Space Agency Remote Sensing Satellite (ERS). Based on cross-spectral analysis of phase gradients, we find that the spatial resolution of ALOS interferograms is 1.3times better than ERS interferograms. The phase noise of ALOS (i.e., line-of-sight precision in the 100-5000-m wavelength band) is 1.6times worse than ERS (3.3 mm versus 2.1 mm). In both cases, the largest source of error is tropospheric phase delay. Vector deformation maps associated with the June 17, 2007 (Father's day) intrusion along the east rift zone of the Kilauea Volcano were recovered using just four ALOS SAR images from two look directions. Comparisons with deformation vectors from 19 continuous GPS sites show rms line-of-site precision of 14 mm and rms azimuth precision (flight direction) of 71 mm. This azimuth precision is at least 4times better than the corresponding measurements made at C-band. Phase coherence is high even in heavily vegetated areas in agreement with previous results. This improved coherence combined with similar or better accuracy and resolution suggests that L-band ALOS will outperform C-band ERS in the recovery of slow crustal deformation. [J71]

"Mechanical engineering's role in multi-disciplinary radar design"

Successful execution of a program and full satisfaction of the customer's requirements is a challenge for any contractor. Raytheon Company responds to this challenge by following a proven program execution methodology. The methodology includes all program aspects from financial planning to engineering to validation and test. This discusses the engineering team and the role of the mechanical engineer. A radar system is ultimately an assembly of advanced electronics and software. However, the design, fabrication, assembly, integration, and test Of this complex system requires a coherent multi-disciplinary approach. Raytheon, like many contractors, chooses to assemble an integrated product team (IPT) including all engineering disciplines. Mechanical engineering is integral to satisfying performance requirements, performing preliminary and detailed design, transition of the design to manufacturing, and implementation of the hardware in the field. During definition, mechanical engineering assists fundamental architecture development, conceptual design, and requirements development which precludes issues that are sometimes ignored to the detriment of many programs. These design issues include environmental protection, structural stiffness to meet deflection requirements, cooling system capacity to properly remove dissipated heat, manufacturability to control cost, maintainability to enable repair in the field, and transportability. Recognizing and trading off these issues early greatly increases the Probability Of satisfying customer objectives. This discusses the approach Raytheon is taking to ensure an overall multi-disciplinary solution to our design challenges from the perspective of the mechanical engineer. [J72]

"Measurements and inferences of raindrop canting angles"

The canting angle distribution of raindrops derived separately from a 2D video disdrometer and from an S-band advanced polarimetric radar are presented. In the former case, measurements were made in both natural and artificial rain. The canting angles showed a symmetric distribution about 0deg with a standard deviation (sigmabeta) of 7deg-8deg in low wind conditions and 12deg in moderate wind conditions. In the radar-based estimates, the histogram of sigmabetaderived from data obtained during a light stratiform rain event with embedded convection shows the mode to be around 7deg, with a significant positive skewness. Around 16% of occurrences exceeded 10deg and 3.3% exceeded 15deg. [J73]

"Metamorphic HEMT MMICs and Modules for Use in a High-Bandwidth 210 GHz Radar"

In this paper, we present the development of advanced W-band and G-band millimeter-wave monolithic integrated circuits (MMICs) and modules for use in a high-resolution radar system operating at 210 GHz. A W-band frequency multiplier by six as well as a subharmonically pumped 210 GHz dual-gate field-effect transistor (FET) mixer and a 105 GHz power amplifier circuit have been successfully realized using our 0.1 mum InAlAs/InGaAs based depletion-type metamorphic high electron mobility transistor (mHEMT) technology in combination with grounded coplanar circuit topology (GCPW). Additionally, a 210 GHz low-noise amplifier MMIC

was fabricated using our advanced 0.05 mum mHEMT technology. To package the circuits, a set of waveguide-to-microstrip transitions has been realized on 50 mum thick quartz substrates, covering the frequency range between 75 and 220 GHz. The presented millimeter-wave components were developed for use in a novel 210 GHz radar demonstrator COBRA-210, which delivers an instantaneous bandwidth of 8 GHz and an outstanding spatial resolution of 1.8 cm. [J74]

"The Compact Polarimetry Alternative for Spaceborne SAR at Low Frequency"

In spaceborne synthetic aperture radar (SAR), a single-polarization on-transmit offers twice the swath width compared to full polarization. This is linked to SAR system design issues, and, without getting into the technical details deserving by themselves a full paper, we can just mention the swath characteristics of ALOS PALSAR (the Advanced Land Observing Satellite, Phased Array L-Band Synthetic Aperture Radar), reducing from 70 km for the dual-pol mode to 30 km for the full polarization mode. The reduced coverage in the full polarization mode has a harmful impact on the revisit time, which is always a major drive for the Earth-observing community. The options chosen up to now for dual-pol system designs (or single-polarization on-transmit) rely on a linear polarization on-transmit [either horizontal (H) or vertical (V)], with two orthogonal polarizations on-receive. Souyris and Raney in earlier papers proposed more pertinent alternatives for the selection of the transmit polarization leading to a better characterization of the scattering mechanisms. In this paper, the analysis is pursued in more depth by including the effect of the ionosphere on the wave propagation and extending the applications to polarimetric interferometry SAR (PolInSAR). A compact mode is developed where the transmit polarization is circular, whereas the only constraint on the two receiving polarizations is independence. Indeed, the choice of the polarizations of the two receive channels does not matter, as any polarization on-receive can be synthesized from these two measurements. This is, however, not the case for the unique transmit polarization. At a low frequency, where the ionosphere has a significant effect, the circular transmit polarization is the only sensible option, as it provides an effective constant polarization as seen by the scattering surface. This is an essential condition for a meaningful multitemporal analysis. Both the polarimetric SAR applications and the PolInSAR appl--ications in the context of this compact polarimetry (CP) mode are explored. A pseudocovariance matrix can be reconstructed following Souyris' proposed approach for distributed targets and is shown to be very similar to the full polarimetric (FP) covariance matrix. The reconstruction of the cross-polarized Sigma0 is shown to be reliable and to have very low sensitivity to Faraday rotation. A PolInSAR vegetation height inversion for P-band is presented and applied to the CP data with a level of performance that is similar to the one derived from FP (a 1.2-m root-mean-square height error on the ONERA Airborne radar (RAMSES) data over the Landes Forest). A procedure is developed to correct for the ionospheric effects for the PolInSAR acquisition in the FP or CP mode and is assessed on the data simulated from an airborne acquisition. The results demonstrate that the technique is efficient and robust. The calibration of CP data is identified as an important challenge to be solved, and some clues are provided to address the problem. [J75]

"Fiber lasers: A future space technology [Jsame article as "Fiber lasers: A future technology for lasers in space", ibid, vol. 23, n. 4, pp. 25-30, 08]"

The constraints of operation in space have largely precluded the use of conventional solid-state laser systems for applications including remote sensing, communication relays, and active laser radars. A new technology, fiber lasers, may offer all of the needed features at an affordable price. An appealing aspect of the fiber laser is that it does not need a rigid optical bench. Only the output end of the fiber need be held in rigid reference to the optical tracking system. Design, fabrication, and testing of the laser resonator is generally the most expensive and longest lead part of the effort for conventional solid-state lasers. Advances in Fiber Optic technology and devices mean that the "fiber laser" need not be a simple device but may be a complex system employing sophisticated technology such as wavelength selective Bragg reflectors and nonlinear optical frequency shifters. Three companies have recently obtained single-mode outputs of 3540 watts single mode at 1.03-1.1 microns. [J76]

"Glacier Volume Changes Using ASTER Satellite Stereo and ICESat GLAS Laser Altimetry. A Test Study on EdgeШуа, Eastern Svalbard"

Currently, one of the major methodological gaps in the observation of glaciers from space is the measurement of volume changes of mountain glaciers and ice caps. In this paper, we present a case study of comparing a digital elevation model derived from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite optical stereo, elevation data derived from Ice, Cloud, and land Elevation Satellite Geoscience Laser Altimeter System (GLAS) laser altimetry, and contour lines from a topographic map from the 1970s. For two ice caps in Eastern Svalbard, Kvalpyntfonna and Digerfonna, we obtain an overall elevation change of -0.55 or -0.61 m/year between 1970 and 2002 (ASTER) or GLAS (2006), respectively. From comparison of different methods and from different quality checks, we estimate the error of this numbers to be on the order of 5%. This paper

demonstrates that and on how long-term glacier volume changes can be observed from space over a large number of ice caps and glaciers. [J77]

"Correction of the Sea State Impact in the L-Band Brightness Temperature by Means of Delay-Doppler Maps of Global Navigation Satellite Signals Reflected Over the Sea Surface"

This paper presents an efficient procedure based on 2-D convolutions to obtain delay-Doppler maps (DDMs) of Global Navigation Satellite Signals reflected (GNSS-R) over the sea surface and collected by a spaceborne receiver. Two DDM-derived observables (area and volume) are proposed to link the sea-state-induced brightness temperature to the measured normalized DDM. Finally, the requirements to use Global Positioning System reflectometry to accurately correct for the sea state impact on the L-band brightness temperature (quantization levels, decimation, truncation, and noise impact) are analyzed in view of its implementation in the Passive Advanced Unit instrument of the Spanish Earth Observation Satellite (SeoSAT/INGENIO) project. [J78]

"Evaluation and Bias Removal of Multilook Effect on Entropy/Alpha/Anisotropy in Polarimetric SAR Decomposition"

Entropy, alpha, and anisotropy (H/alpha/A) of the polarimetric target decomposition have been an effective and popular tool for polarimetric synthetic aperture radar (SAR) image analysis and for a geophysical parameter estimation. However, multilook processing can severely affect the values of these parameters. In this paper, a Monte Carlo simulation is used to evaluate and remove the bias generated by the multilook effect on these parameters for various media composed of grassland, forest, and urban returns. Due to insufficient averaging, entropy is underestimated, and anisotropy is overestimated. We also found that the bias in the alpha angle can be either underestimated or overestimated depending on scattering mechanisms. Based on simulation results, efficient bias removal procedures have been developed. In particular, the entropy bias can be precisely corrected, and the amount of correction is independent of the radar frequency and SAR systems. Data from L-band Advanced Land Observing Satellite/phased array type L-band SAR, German Aerospace Research Center (DLR)/enhanced SAR, Jet Propulsion Laboratory (JPL)/airborne SAR, and X-band polarimetric and interferometric SAR are used for demonstration in this paper. [J79]

"Crossroads risk assessment using GPS and inter-vehicle communications"

Recent developments in inter-vehicle communications (IVC) focus on the conception of suitable hardware and communications protocols. We contribute to this effort by analysing the performance of IVC through a vehicular application approach. The study aims to measure the contribution of IVC in comparison with traditional safety sensors on an advanced driver assistance scheme (ADAS) system. We choose to study the risk assessment in crossroads approaching. The system is based on a standard 802.11 technology combined to a standard low-cost GPS receiver. The performance is analysed regarding the application showing the feasibility of the system and its integration on board our prototype LARA [J80]

"Concurrent Operation of Two Over-the-Horizon Radars"

By exploiting the reflective and refractive nature of high-frequency (HF) radiowave propagation through the ionosphere or the conducting sea surface, over-the-horizon radar (OTHR) systems perform wide-area surveillance at long range well beyond the limit of the horizon of conventional line-of-sight (LOS) radars. Improved characterizations of the targets can be achieved by using multiple OTHRs operating simultaneously as compared to a single OTHR operating alone. In this paper, we consider concurrent operations of two OTHR systems that occupy the same frequency band with different chirp waveforms. The objective is to respond to the advanced wide-area surveillance needs without reducing the wave repetitive frequency. For this purpose, a new cross-radar interference cancellation technique is developed and its effectiveness is verified through both analytical and simulation results [J81]

"Enhanced ADS-B Research"

Automatic dependent surveillance-broadcast (ADS-B) is gaining acceptance around the world as the next-generation surveillance technology. It can provide surveillance to air traffic controllers to support today's procedures as well as surveillance in the cockpit to support air-to-air applications. Pilots and ground personnel have begun to benefit from this technology but further benefits from technological improvements can still be realized. These improvements include security, increased data capacity, and advanced applications (4D trajectory and data exchange). To this end research is currently being performed by Sensis Corporation in cooperation with NASA Glenn research center to provide enhancements to the ADS-B UAT (universal access transceiver) data link. The research goal is to encourage user acceptance by improving upon existing capability

and usability along with providing a roadmap and demonstrations of future data link capability [J82]

"Application of ENVISAT ASAR Data in Mapping Rice Crop Growth in Southern China"

This research letter presents preliminary results of mapping rice crop growth using ENVISAT advanced synthetic aperture radar (ASAR) alternating polarization HH/HV data. Four ASAR HH/HV images were collected in the early rice-growth cycle in the test site in 2006, and the temporal response of ASAR data to the rice field was analyzed. The height and biomass of rice were measured during acquisition of ASAR data, and empirical relationships were established between the backscattering coefficient and these two parameters. Based on the temporal variation of the radar response, a method for mapping a rice growth area was developed using the combination of ASAR HH and HV polarization data between two acquisition dates. The results confirm that C-band SAR data have great potential in the development of an operational system for monitoring rice crop growth in Southern China. [J83]

"Radar Signatures of Sahelian Surfaces in Mali Using ENVISAT-ASAR Data"

This paper presents an analysis of ENSIVAT advanced synthetic aperture radar data acquired over a Sahelian region located in Mali, West Africa. The considered period is 2004-2005 and includes two rainy seasons. Emphasis is put on two ScanSAR modes, namely, the global monitoring (GM) and the wide swath (WS) modes characterized by spatial resolutions of about 1 km and 150 m, respectively. Results show that the WS mode offers better performance in terms of radiometric resolution, radiometric stability, and speckle reduction than the GM mode. The latter is more appropriate for studies at large scale (> 10 times 10 km). In both modes, pronounced angular and temporal signatures are observed for most soil surfaces, and azimuthal effects are observed on markedly orientated rocky surfaces. In contrast, polarization differences (VV/HH) are small during the dry season except on flat loamy soil surfaces. Finally, a relationship is observed between the normalized WS backscattering signal at HH polarization and the surface soil moisture of sandy soils. [J84]

"From circuit topology to behavioural model of power amplifier dedicated to radar applications"

A new behavioural model of a power amplifier (PA) at system level is presented, dedicated to radar applications. This model, which is able to take into account output loading impedance mismatch, is based on a similar topology to the PA's circuit. The model, implemented in Agilent Advanced Design System (ADS), is validated for different loading impedances, until VSWR=2 (voltage standing wave ratio), on the PA's bandwidth. This approach permits an extraction, resulting from simple CW measurements or simulations, and easy model implementation. This work has been supported by DGA (French Defense and Security Agency) [J85]

"2006's Wearable Computing Advances and Fashions"

The 10th annual IEEE Computer Society International Symposium on Wearable Computers took place on the shores of Lake Geneva, Switzerland, in October 2006. ISWC is the premier conference in wearable computing, featuring the latest in technical advances and fashions. Attendees came from both academia and industry, representing a broad spectrum of nationalities and technical interests, with more than 150 participants from 19 countries. The papers, posters, and demonstrations at the conference focused on several themes. The conference had sessions on activity recognition, location systems, interface evaluation, input devices and sensors, and wearability [J86]

"Experimental Study of Phase Pushing in a Fundamental-Mode Multiple-Beam Klystron"

The authors present the results of experimental measurements of the radio frequency phase as a function of cathode voltage for an eight-beam four-cavity multiple-beam klystron (MBK) operated at a driven frequency of 3.25 GHz. The phase-pushing factor was measured in both the small- and large-signal regimes of amplifier operation and was found to be 0.0134deg/V and 0.0148deg/V, respectively. The experiment was also modeled with a simple analytic function and with telegraphist's equations solution for linear beam amplifiers, a multiple-beam 2.5-D nonlinear klystron code, with both methods yielding good agreement with the measured data. The low values for the phase-pushing factor are a benefit of the MBK's high-perveance operation that results in a shorter circuit length relative to single-beam devices of comparable power. These advantages contribute to the growing interest in the use of multiple-beam devices for high-power phase-sensitive applications such as advanced radar and high-data-rate digital communications [J87]

"Service-Oriented E-Learning Platforms: From Monolithic Systems to Flexible Services"

The learning management system (LMS) has dominated Internet-based education for the past two decades. However, the traditional LMS is failing to keep pace with advances in Internet technologies and social

interactions online. To support technological diversity, current frameworks such as the e-learning framework (ELF), the IMS abstract framework, and the open knowledge initiative (OKI) have defined the initial steps toward service-oriented e-learning platforms. Next-generation platforms will be based on these service-oriented visions. The authors discuss LMS evolution and present core challenges that must be addressed to achieve information interoperability in next-generation e-learning platforms [J88]

"Importance sampling for characterizing STAP detectors"

This paper describes the development of adaptive importance sampling (IS) techniques for estimating false alarm probabilities of detectors that use space-time adaptive processing (STAP) algorithms. Fast simulation using IS methods has been notably successful in the study of conventional constant false alarm rate (CFAR) radar detectors, and in several other applications. The principal objectives here are to examine the viability of using these methods for STAP detectors, develop them into powerful analysis and design algorithms and, in the long term, use them for synthesizing novel detection structures. The adaptive matched filter (AMF) detector has been analyzed successfully using fast simulation. Of two biasing methods considered, one is implemented and shown to yield good results. The important problem of detector threshold determination is also addressed, with matching outcome. As an illustration of the power of these methods, two variants of the square-law AMF detector that are thought to be robust under heterogeneous clutter conditions have also been successfully investigated. These are the envelope-law and geometric-mean STAP detectors. Their CFAR property is established and performance evaluated. It turns out the variants have detection performances better than those of the AMF detector for training data contaminated by interferers. In summary, the work reported here paves the way for development of advanced estimation techniques that can facilitate design of powerful and robust detection algorithms [J89]

"Bistatic SAR ATR"

With the present revival of interest in bistatic radar systems, research in that area has gained momentum. Given some of the strategic advantages for a bistatic configuration, and technological advances in the past few years, large-scale implementation of the bistatic systems is a scope for the near future. If the bistatic systems are to replace the monostatic systems (at least partially), then all the existing usages of a monostatic system should be manageable in a bistatic system. A detailed investigation of the possibilities of an automatic target recognition (ATR) facility in a bistatic radar system is presented. Because of the lack of data, experiments were carried out on simulated data. Still, the results are positive and make a positive case for the introduction of the bistatic configuration. First, it was found that, contrary to the popular expectation that the bistatic ATR performance might be substantially worse than the monostatic ATR performance, the bistatic ATR performed fairly well (though not better than the monostatic ATR). Second, the ATR performance does not deteriorate substantially with increasing bistatic angle. Last, the polarimetric data from bistatic scattering were found to have distinct information, contrary to expert opinions. Along with these results, suggestions were also made about how to stabilise the bistatic-ATR performance with changing bistatic angle. Finally, a new fast and robust ATR algorithm (developed in the present work) has been presented. [J90]

"SIMS at sea"

The need for a new 25-knot lifeboat offered the RNLI the opportunity to capitalise on engineering advancements. The author assesses the institution's use of Systems and Integrated Management System (SIMS) to advance information, control and safety. SIMS is a distributed network-based arrangement of computers and data input/output devices designed to assist in the management, operation, control and data recording (mission logging) of this highly advanced rescue vessel. The SIMS system has been designed to make the lifeboat crew's job easier. It allows the removal of non-essential functions from the respective systems and displays on screen the information that the crew need most for both training and operations. Each screen allows the user to view information from all the integrated systems such as navigation and radar. This means that the crew can now stay safely in their seats, removing the possibility of injury that could result from moving about the cabin in heavy seas. It also has five potential power sources, a solid state computer memory which replaces hard drives, a shock mounted rack, waterproof computer boxes, screens and trackballs. The SIMS rack consists of six computers (each capable of running the system by itself) as well as all the other processors required to monitor and run the boat's systems. [J91]

"35 GHz compact radar using fan beam antenna array for obstacle detection"

A 35 GHz, magnetron-based, compact pulse radar is presented. It contains some novel solutions of four electrically switched slot array antennas having fan beam patterns, solid-state modulator adaptive for the miniature magnetron and digital receiver techniques with advanced processing. It is designed for obstacle and

rain detection for collision warning in helicopter applications. [J92]

"Fractal generation of rain fields: synthetic realisation for radio communications systems"

The spatio-temporal variation of rain fields is a key input into the development of radio systems which operate at frequencies above 10 GHz in a spectrally efficient fashion. Fractal methods have been proven helpful in the analysis and synthesis of rain fields. A fractal model is presented for the simulation of meteorologically representative rain fields, using an additive iterative process in the logarithmic domain. The resulting simulated rain fields are monofractal fields that have appropriate spectral density exponent, fractal dimension and behaviour that is consistent with radar analyses of convective or stratiform types of events. Justification to use a monofractal method of simulation is presented through the analysis of the moment scaling function for fields of rain rate and log rain rate values recorded by the Chilbolton Advanced Meteorological Radar, based in the south of England. The results of the analysis indicate that log rain fields can be analysed and simulated by using monofractal techniques with sufficient accuracy for the purposes of synthesising rain fields for communication systems design and operation. Cumulative distributions of rain rate exceedance derived from the simulated fields are compared with the measured rain gauge data and curves calculated from the ITU-R rain models, with promising results. [J93]

"High Fidelity Circular Array Simulation"

This describes a unique approach to performing high fidelity UHF circular array simulations on a High Performance Computer (HPC). Traditional airborne surveillance simulations have been limited in either spatial or temporal fidelity due to the expensive software and hardware requirements. Recently, advances have been made which provide the rapid deployment of high fidelity scenarios through a modular visual programming environment on an HPC. Based on the visual programming environment Khoros, the Radar Analysis Simulation Tool (RAST-K) is a flexible simulation for quickly prototyping airborne surveillance configurations containing radar system features, point targets, and USGS maps. Additionally, RAST-K has been ported to a Linux cluster to simulate realistic flight scenarios. As these scenarios involve changing characteristics between Coherent Processing Intervals (CPIs), additional interfaces were developed to control platform, target, and environmental attributes, as well as partition the simulations across the resource of processors. This paper will discuss these topics by providing an overview of the RAST-K simulation and its use in the simulation of a circular UHF antenna configuration. After which, the simulation of realistic flight scenarios through the use of the HPC is discussed, along with relevant results. [J94]

"Atmospheric Components Determination From Ground-Level Measurements During the Spectra Barax Campaigns (SPARC) Field Campaigns"

The surface processes and ecosystem changes through response analysis (SPECTRA) Barrax campaigns were validation campaigns developed in the framework of the SPECTRA mission in order to verify that the geophysical data products provided by satellite imagery are consistent with the measurements made by independent means. Two campaigns took place in Barrax, Spain, during the summers of 2003 and 2004. This paper presents the results of the characterization of the atmospheric composition from solar radiation, radiosoundings, and lidar measurements. Several potentially interesting situations involving atmospheric layers with different types of aerosols and water content are discussed. The presence of a residual layer capping the mixing layer during some days of the 2003 campaign and the arrival of a dust-rich air mass from the Sahara on the last two days of the 2004 campaign provide some relevant aerosol vertical profiles to test atmospheric correction algorithms. The study of the effects of these atmospheric situations on radiative transfer calculations is required in the development and validation of advanced atmospheric correction codes for the new generation of Earth observation systems. [J95]

"Superconducting High-Resolution Low-Pass Analog-to-Digital Converters"

HYPRES has developed a high-resolution, dynamically programmable analog-to-digital converter (ADC) for radar and communications applications. The ADC uses the phase modulation-demodulation low-pass architecture and on-chip digital filtering. Detailed experimental results at 20 GHz clock frequency of the ADC chip fabricated with a 1 kA/cm2Nb process are presented and discussed. In addition to the standard ADC configuration, different ADC modifications are described. In the multi-rate ADC, the modulator sampling frequency is the twice the clock frequency for the time-interleaved digital filter. In addition to the standard parallel-output ADC, a serial output ADC and its interface to room temperature electronics are developed. This serial ADC chip fabricated with the advanced HYPRES 4.5 kA/cm2process operated up to 34 GHz clock. As a major step toward commercialization of superconducting electronics, an ADC chip was successfully packaged on a cryocooler where it showed reduced performance up to 11.52 GHz clock. [J96]

"Degrading effects of the lower atmosphere on long-range airborne synthetic aperture radar imaging"

The imaging performance of airborne synthetic aperture radar (SAR) systems has advanced to the point that the effects of clear-air refractive index perturbations cannot be ignored. Operating at long ranges, and low grazing angles, in particular, require propagation geometries through regions of the lower atmosphere that may cause noticeable and, sometimes, severe degradation of the images. The range of image anomalies that can be attributed to the atmospheric boundary layer (ABL) is illustrated, the pertinent characteristics of the ABL is discussed, a first-order SAR imaging model that incorporates the refractive index perturbations associated with the ABL is developed and the magnitude of the image anomalies resulting from measured refractive index perturbations is estimated. The model predictions correlate well with the observed image anomalies and measured properties of the ABL. On the basis of theory and measurements, it is expected that the degrading effect of clear-air atmospheric refractive index perturbations is much more common than previously thought and may be a limiting factor for long-range SAR imaging performance. [J97]

"Weather Radar Equation Correction for Frequency Agile and Phased Array Radars"

This paper presents the derivation of a correction to the Probert-Jones weather radar equation for use with advanced frequency agile, phased array radars. It is shown that two additional terms are required to account for frequency hopping and electronic beam pointing. The corrected weather radar equation provides a basis for accurate and efficient computation of a reflectivity estimate from the weather signal data samples. Lastly, an understanding of calibration requirements for these advanced weather radars is shown to follow naturally from the theoretical framework. [J98]

"Vacuum Electronics: Status and Trends"

The vast preponderance of US radar transmitters today use vacuum electronic amplifiers, spanning the spectrum from UHF to EHF. Enhancements to performance, reliability, and cost of ownership are being applied continuously to these systems: routine in-service life extensions mandate continuing vacuum electronics research and development to support system needs for the foreseeable future. In addition, exciting advances in vacuum electronics will provide dramatic improvements in millimeter-wave radar resolution, broadband low-noise power at microwave frequencies, compact high power sources operating at lower voltages, and life-cycle cost improvement. Recent progress in key enabling technologies, e.g., advanced device modeling and micro-fabrication, is expected to continue. This reviews the status and trends of vacuum electronics, with selected applications emphasizing recent advances in device performance in the microwave regime: multiple-beam klystrons (MBKs), microwave power modules (MPMs), and gyro-amplifiers in the millimeter-wave regime. [J99]

"Spatial diversity in radars-models and detection performance"

Inspired by recent advances in multiple-input multiple-output (MIMO) communications, this proposal introduces the statistical MIMO radar concept. To the authors' knowledge, this is the first time that the statistical MIMO is being proposed for radar. The fundamental difference between statistical MIMO and other radar array systems is that the latter seek to maximize the coherent processing gain, while statistical MIMO radar capitalizes on the diversity of target scattering to improve radar performance. Coherent processing is made possible by highly correlated signals at the receiver array, whereas in statistical MIMO radar, the signals received by the array elements are uncorrelated. Radar targets generally consist of many small elemental scatterers that are fused by the radar waveform and the processing at the receiver, to result in echoes with fluctuating amplitude and phase. It is well known that in conventional radar, slow fluctuations of the target radar cross section (RCS) result in target fades that degrade radar performance. By spacing the antenna elements at the transmitter and at the receiver such that the target angular spread is manifested, the MIMO radar can exploit the spatial diversity of target scatterers opening the way to a variety of new techniques that can improve radar performance. This paper focuses on the application of the target spatial diversity to improve detection performance. The optimal detector in the Neyman-Pearson sense is developed and analyzed for the statistical MIMO radar. It is shown that the optimal detector consists of noncoherent processing of the receiver sensors' outputs and that for cases of practical interest, detection performance is superior to that obtained through coherent processing. An optimal detector invariant to the signal and noise levels is also developed and analyzed. In this case as well, statistical MIMO radar provides great improvements over other types of array radars. [J100]

"Distinguished Lecturers Program"

One of the general trends of the MEMS sensors business is the utilization of the technology to satisfy harsh environment requirements (temperature, shock, vibration, environment security). The conjunction of material

(standard Silicon, SiC or SOI), with complex micromachining techniques and advanced assembly techniques are the key to provide robust sensors with a miniimum concession on specification. The goal of this paper is to present progress on gun hard (>20,000 g) and wide temperature range MEMS accelerometers (-120Г‚В°C to +180Г‚В°C). Concrete solutions and results (out of more than 500 tested products)) will be presented and discussed in detail. [J101]

"Editorial: Advances in synthetic aperture radar"

This special issue includes papers selected from EUSAR 2004. The publisher suggested including the top 10% of the EUSAR 2004 programme. As we had 280 presented papers including posters we came up with a selection of 26 papers. Because of the large number of pages this special issue has therefore been published in two parts. With EUSAR a unique, worldwide forum for everyone working in the SAR field-scientists, system designers, teachers and users-was established. Each EUSAR conference represents the most recent state-of-the-art in SAR in the world and exhibits perspectives for future activities. The selection of papers included in this double issue reflects these intentions. [J102]

"Exploiting nonacoustic sensors for speech encoding"

The intelligibility of speech transmitted through low-rate coders is severely degraded when high levels of acoustic noise are present in the acoustic environment. Recent advances in nonacoustic sensors, including microwave radar, skin vibration, and bone conduction sensors, provide the exciting possibility of both glottal excitation and, more generally, vocal tract measurements that are relatively immune to acoustic disturbances and can supplement the acoustic speech waveform. We are currently investigating methods of combining the output of these sensors for use in low-rate encoding according to their capability in representing specific speech characteristics in different frequency bands. Nonacoustic sensors have the ability to reveal certain speech attributes lost in the noisy acoustic signal; for example, low-energy consonant voice bars, nasality, and glottalized excitation. By fusing nonacoustic low-frequency and pitch content with acoustic-microphone content, we have achieved significant intelligibility performance gains using the DRT across a variety of environments over the government standard 2400-bps MELPe coder. By fusing quantized high-band 4-to-8-kHz speech, requiring only an additional 116 bps, we obtain further DRT performance gains by exploiting the ear's insensitivity to fine spectral detail in this frequency region. [J103]

"Visualization of structured nonuniform grids"

Operational forecasters and weather researchers need accurate visualization of atmospheric data from both computational models and observed data. Although these two applications share some requirements, they have different needs and goals. We've developed a visualization tool for atmospheric science researchers and research weather forecasters that allows the 3D visualization of measured radar data and rendered numerical model data to show the 3D structures as well as how the weather event would look when observed in the field. Our system lets us load the original data directly onto the graphics hardware, with the grid mapping from the rendering space to the grid space programmed on the GPU. This method is flexible enough to handle the grids important in meteorological research and enables the application of advanced visualization methods available in texture-based slicing systems. The visually accurate rendering of weather data can be useful for training weather spotters, evaluating forecasting models, training forecasters to interpret radar data, and comparing sensor data to observed weather events. [J104]

"Advances in non-linear apodization"

Selected new methods and applications of non-linear apodization for irregularly-shaped and parse coherent apertures and arrays are presented. The benefits include unproved impulse response performance, i.e., reduced peak sidelobes and integrated sidelobe power, along with improved mainlobe resolution, compared to classic windowing techniques. Nonlinear apodization (NLA) techniques can also serve as powerful engines for effective superresolution and bandwidth extrapolation of coherent data for filling sparse apertures. The sparse aperture filling property of superresolution algorithms for radar data forms the basis for a new concept which is introduced here: synthetic multiple aperture radar technology (SMART). Increased swath and/or reduced antenna size are some of the benefits postulated for SMART applied to synthetic aperture radar (SAR) systems. The benefits of these new methods and applications for nonlinear apodization are then demonstrated for two specific applications: 1) sidelobe control for Y-type synthetic aperture radiometers, such as the European Soil Moisture and Ocean Salinity (SMOS) system (Kerr et al.) and JPL's proposed GeoSTAR (Lambrigsten) concept; and, 2) filling of sparse synthetic aperture radar data by exploiting the bandwidth extrapolation properties of nonlinear apodization based superresolution techniques. The methods that have been developed and demonstrated herein have potential application to a wide range of passive and active microwave remote sensing and radar systems.

[J105]

"Knowledge-aided adaptive radar at DARPA: an overview"

For the past several years, the Defense Advanced Research Projects Agency (DARPA) has been pioneering the development of the first ever real-time knowledge-aided (KA) adaptive radar architecture. The impetus for this program is the ever increasingly complex missions and operational environments encountered by modern radars and the inability of traditional adaptation methods to address rapidly varying interference environments. The DARPA KA sensor signal processing and expert reasoning (KASSPER) program has as its goal the demonstration of a high performance embedded computing (HPEC) architecture capable of integrating high-fidelity environmental knowledge (i.e., priors) into the most computationally demanding subsystem of a modern radar: the adaptive space-time beamformer. This is no mean feat as environmental knowledge is a memory quantity that is inherently difficult (if not impossible) to access at the rates required to meet radar front-end throughput requirements. In this article, we will provide an overview of the KASSPER program highlighting both the benefits of KA adaptive radar, key algorithmic concepts, and the breakthrough look-ahead radar scheduling approach that is the keystone to the KASSPER HPEC architecture. [J106]

"Demonstration of advanced reconnaissance techniques with the airborne SAR/GMTI sensor PAMIR"

PAMIR (Phased Array Multifunctional Imaging Radar) is an experimental airborne radar system that has been designed and built by the Research Institute for High Frequency Physics and Radar Techniques (FHR) of Forschungsgesellschaft fьr Angewandte Naturwissenschaften (FGAN). The goal is to meet the growing demands for future reconnaissance systems with respect to flexibility and multi-mode operation by the use of an electronically steerable phased array antenna. The X-band system with a bandwidth of 1.8 GHz serves as a platform for different tasks. One of the main objectives is to demonstrate synthetic aperture radar (SAR) imaging at a very high resolution and for a long range. The fine resolution will also be applied for inverse SAR (ISAR) imaging of ground moving targets. Moreover, five parallel receiving channels allow array processing techniques like ground moving target indication (GMTI) via space-time adaptive processing, electronic counter-counter-measures and interferometric SAR with a very high 3D-resolution. A multi-channel scan-MTI mode with a range resolution adapted to the target size allows for a wide area GMTI operation that can be complemented by target tracking. Together with the predecessor system AER-II, operating at a frequency band contained in that of PAMIR, the possibility of experimental investigation of bistatic SAR is given. SAR images of large urban areas and ISAR images of moving objects, both with finest resolution down to the sub-decimetre scale, are presented. Results of GMTI in a wide area scanning mode and broadband bistatic experiments including true bistatic SAR processing are shown as well. [J107]

"The Potential of Low-Frequency SAR Systems for Mapping Ionospheric TEC Distributions"

Ionospheric propagation effects have a significant impact on the signal properties of low-frequency synthetic aperture radar (SAR) systems. Range delay, interferometric phase bias, range defocusing, and Faraday rotation are the most prominent ones. All the effects are a function of the so-called total electron content (TEC). Methods based on two-frequency global positioning system observations allow measuring TEC in the ionosphere with coarse spatial resolution only. In this letter, the potential of broadband L-band SAR systems for ionospheric TEC mapping is studied. As a basis, the dispersive nature of the ionosphere and its effects on broadband microwave radiation are theoretically derived and analyzed. It is shown that phase advance and group delay can be measured by interferometric and correlation techniques, respectively. The achievable accuracy suffices in mapping small-scale ionospheric TEC disturbances. A differential TEC estimator that separates ionospheric from tropospheric contributions is proposed [J108]

"Measurement of Correlation Functions and Power Spectra in Clouds Using the NRL WARLOC Radar"

The Naval Research Laboratory W-band Advanced Radar for Low Observable Control (WARLOC) is a high-power 94-GHz radar, with 3-10-kW average and 80-kW peak power, now set up on the western shore of the Chesapeake Bay. It has three orders of magnitude more power and sensitivity than other W-band radar systems. This enables cloud reflectivity to be measured with high signal-to-noise ratios and a resolution of about 15 m over a two (or three)-dimensional region, which can be as large as tens of kilometers on a side. This allows imaging of the internal structure of clouds over great distances in very great detail. At the shortest scale lengths, the structure has a speckle pattern indicating that it is governed at least in part by stochastic processes. The WARLOC data allow the reflectivity correlation function and its Fourier transform, which is the power spectrum, to be computed for scale lengths ranging from 30 m to 10 km. For measurements taken of cirrus clouds on

several occasions as well as one case of a precipitating cloud, it was found that for small correlation distance r, the correlation function usually decreases as r2/3, or, equivalently, the wavenumber spectrum scales as k-5/3, where k is the wavenumber. This suggests that fluid turbulence in the inertial range is playing a role; however, unlike classical fluid turbulence, the results suggest that the turbulence here is generally quite anisotropic. Furthermore, for longer scale lengths (the outer range according to the Kolmogorov theory), the reflectivity fluctuations usually show a wavelike behavior in the vertical direction but only occasionally in the horizontal direction [J109]

"Knowledge-aided signal processing: a new paradigm for radar and other advanced sensors"

Recently, significant progress has been made in the development of physics-based, knowledge-aided (KA) signal processing strategies supported by improvements in real-time embedded computing architectures. These developments provide designers of advanced sensor systems an unprecedented degree of flexibility when implementing next generation adaptive sensor systems. In the case of radar, this has been manifested in the first ever, real-time, KA space-time adaptive processing (KA-STAP) system for advanced clutter/interference suppression. This paper provides exemplars of real-world effects giving rise to the need for "intelligent" adaptation schemes and overviews the KA approach to sensor signal processing in some detail. Moreover, we survey a collection of papers describing recent KA sensor research that follow in this issue [J110]

"Off-highway obstacle detection"

The biggest conclusion is that intensity of radar backscatter returns is a poor indicator of danger to a vehicle despite the attempts of several projects to show otherwise. Still, our method violates this finding at some level. An image of backscatter intensities is filtered with various image processing techniques then is thresholded as if it has become an image of risks or confidences. Current research is investigating discriminant functions that allow arbitrary numbers of classes and can use separability and discriminability as confidences instead of a filtered version of intensity. It cannot be overemphasized that this system was designed as an add-on sensor to an already operable autonomous vehicle. As such, it is not sufficient as a primary or stand-alone sensor in an unstructured environment. Radar techniques to detect road edges [Kaliyaperumal et al., 2001], [Nikolova and Hero, 2000] or terrain quality would fill these gaps and allow a radar-only, all-weather autonomous platform. Autonomous radar navigation is possible with proper scoping of the problem. On highways this means ignoring cross-sections smaller than a motorcyclist. Off highway the solutions must be a little more creative, but still exist. Applying image processing techniques already well developed by the computer vision field and avoiding the assumption that intensity of backscatter is a feature directly related to obstacle danger will help advance this goal. Small radar systems have recently become very good, but they do not solve the problem alone. Just as other sensors like cameras and LIDAR require algorithms to convert from raw data to obstacle classifications, so too should radar users not expect to achieve good performance by simply thresholding the output from hardware. If radar is seen as just another imaging source like a camera, much work can be accomplished using the existing arsenal of image processing [J111]

"Simultaneous measurements of ku- and ka-band sea surface cross sections by an airborne Radar"

The dual-frequency Airborne Precipitation Radar-2 (APR-2) was deployed during the Wakasa Bay Experiment in 2003, for validation of the Advanced Microwave Scanning Radiometer-EOS. Besides providing extensive observations of diverse precipitating systems, this Ku-(13.4 GHz) and Ka-band (35.6 GHz) cross-track scanning radar measured sea surface backscatter simultaneously. While the characteristics of the normalized sea surface cross section sigma0at Ku-band are well understood and widely published, the existing experimental data concerning sigma0at Ka-band are scarce and results are inconsistent. In this letter, the Ku/Ka-band sigma0measurements collected by APR-2, together with the estimated uncertainties, are discussed. In general, the measured sigma0 at Ka-band at around 10deg incidence angle appears to be close to that at Ku-band sigma0, and Ka-band exhibits a nonnegligible difference in wind dependence with respect to Ku-band for moderate to high winds [J112]

"Advance Path Measurement for Automotive Radar Applications"

Millimeter-wave automotive radars are currently being used for adaptive cruise control. To extend their application to collision warning and collision avoidance, increased capability is required in the assessment of hazards and the environment. A signal processing scheme called the advance path measurement (APM) algorithm, which extracts the trajectory of the road path ahead of a radar-equipped vehicle, is presented as a step toward increasing current capabilities. A millimeter-wave radar-equipped vehicle with data logging facilities was used to record real-time millimeter-wave radar data. The recorded data were used as the primary input to

the algorithm discussed in this paper. The data were signal processed to generate an image, which was then analyzed using image processing techniques to extract road edge features, using thresholding, peak detection, and Hough transformation. The performance of the APM algorithm was examined by comparing the radar-derived radius of curvature with a digital map database, global positioning system (GPS) position, and yaw-rate data. The results obtained from the radar-derived APM algorithm provide an encouraging basis for continuing its development [J113]

"ICARUS: imaging pulse compression algorithm through remapping of ultrasound"

In this work, we tackle the problem of applying to echographic imaging, those synthetic aperture focusing techniques (SAFT) in the frequency domain commonly used in the field of synthetic aperture radars (SAR). The aim of this research is to improve echographic image resolution by using chirp transmit signals, and by performing pulse compression in both dimensions (depth and lateral). The curved geometry present in the unfocused radio-frequency (RF) ultrasonic image is the main cause of inaccuracy in the direct application of frequency domain SAFT algorithms to echographic imaging. The focusing method proposed in this work, after pulse compression in the depth dimension, performs lateral focusing in the mixed depth-lateral spatial frequency domain by means of a depth variant remapping followed by lateral pulse compression. This technique has the advantage of providing a resolution that is uniform in nonfrequency selective attenuation media, and improved with respect to conventional time domain SAFT, without requiring the acquisition and processing of channel data necessary for the most advanced synthetic transmit aperture techniques. Therefore, the presented method is suitable for easy real-time implementation with current generation hardware. [J114]

"Active video-based surveillance system: the low-level image and video processing techniques needed for implementation"

The importance of video surveillance techniques has considerably increased since the latest terrorist incidents. Safety and security have become critical in many public areas, and there is a specific need to enable human operators to remotely monitor the activity across large environments. For these reasons, multicamera systems are needed to provide surveillance coverage across a wide area, ensuring object visibility over a large range of depths. In the development of advanced visual-based surveillance systems, a number of key issues critical to its successful operation must be addressed. This article describes the low-level image and video processing techniques needed to implement a modern surveillance system. In particular, the change detection methods for both fixed and mobile cameras (pan and tilt) are introduced and the registration methods for multicamera systems with overlapping and nonoverlapping views are discussed. [J115]

"Optimal chip-package codesign for high-performance DSP"

In high-performance DSP systems, the memory bandwidth can be improved using high-density interconnect technology and appropriate memory mapping. High-density MCM and flip-chip solder bump technology is used to achieve a system with an I/O bandwidth of 100 Gb/s/cm2 die. The use of DRAMs in these systems usually make the performance of these systems poor, and some algorithms make it difficult to fully utilize the available memory bandwidth. This paper presents the design of a fast Fourier transform (FFT) engine that gives SRAM-like performance in a DRAM-based system. It uses almost 100% of the available burst-mode memory bandwidth. This FFT engine can compute a million-point FFT in 1.31 ms at a sustained computation rate of 8.64 Ч 1010floating-point operations per second (FLOPS). This is at least an order of magnitude better than conventional systems. [J116]

"Next generation of GUIDAR technology"

The next generation of guided radar (GUIDAR) is based on ultra wide band (UWB) radar signal processing. Just as spread spectrum technology has revolutionized the communications industry UWB is dramatically changing radar signal processing. These advanced signal processing techniques are adapted to leaky coaxial cable technology in the next generation GUIDAR to provide new features and enhanced performance. At the core of the new technology is an ultra high-speed digital correlator implemented in a field programmable gate array (FPGA). Complementary orthogonal codes based on Golay codes are used to produce thumbtack correlation functions simultaneously in multiple range bins. The net result is "near continuous wave (CW)" performance (97% duty cycle) in forty to eighty 11.6-meter long-range bins with targets located within one meter along the length of cable. This is a dramatic improvement over the 3% duty cycle of the original GUIDAR and the typical 100 to 200 meter long zones of current CW leaky cable sensors. Orthogonal complementary codes are transmitted on each of two leaky coaxial cables. The responses from the parallel receive cables are fed to a direct digital receiver. The orthogonal nature of the code allows the composite coded pulse response to be de-multiplexed into the independent response for each of the two cables. This ultra-high speed correlation process

involves the addition and subtraction of the sampled in-phase and quadrature-phase responses to the multiple range bin accumulators at 10 million samples per second. Synchronous sampling at twice the chip rate ensures that each target is observed in three adjacent sample bins. The phase and amplitude response in the three adjacent samples are combined to precisely pinpoint (within 1 meter) the locations of targets along the length of each of the two cables. The ability to precisely locate and track multiple simultaneous targets on each of two cables leads to numerous new features and performance benef--its relative to existing leaky cable sensors. With a separate calibrated threshold for every meter of cable the sensor sensitivity is much more uniform and installation restrictions on burial depth, cable spacing, and medium homogeneity can be relaxed. Potential sources of nuisance alarms can easily be located and overcome. The pinpoint location can be used to provide better CCTV assessment, target capture for video motion sensors and more effective response to intrusions. Through the use of parallel cables the sensor can be used to detect the direction of crossing and to classify targets such as small animals, people, and vehicles. This patented next generation of GUIDAR technology represents a dramatic step forward from that which was introduced at the 1976 Carnahan Conference in Lexington, Kentucky, and the numerous CW leaky coaxial cable sensors that evolved from that work. This technology effectively addresses residential, commercial, industrial, and governmental requirements including those relating to homeland security, military operations, and prisons. [J117]

"Highly integrated direct conversion receiver for GSM/GPRS/EDGE with on-chip 84-dB dynamic range continuous-time ΣΔ ADC"

This paper describes a highly digitized direct conversion receiver of a single-chip quadruple-band RF transceiver that meets GSM/GPRS and EDGE requirements. The chip uses an advanced 0.25-μm BiCMOS technology. The I and Q on-chip fifth-order single-bit continuous-time sigma-delta (ΣΔ) ADC has 84-dB dynamic range over a total bandwidth of ±135 kHz for an active area of 0.4 mm2. Hence, most of the channel filtering is realized in a CMOS IC where digital processing is achieved at a lower cost. The systematic analysis of dc offset at each stage of the design enables to perform the dc offset cancellation loop in the digital domain as well. The receiver operates at 2.7 V with a current consumption of 75 mA. A first-order substrate coupling analysis enables to optimize the floor plan strategy. As a result, the receiver has an area of 1.8 mm2. [J118]

"Recent advances on TD-SCDMA in China"

China has fully embraced the remarkable growth and unprecedented penetration of mobile services, and has become the world's largest mobile cellular market. TD-SCDMA was proposed by the China Wireless Technology Standard (CWTS) Group in 1998, approved as one of the 3G standards by ITU in May 2000, and joined 3GPP in March 2001. This has been a major effort by China to advance its mobile communication systems and facilitate its own technological development in this critical area. TD-SCDMA, a combination of TDD and synchronous CDMA, offers several unique advantages over its alternatives, WCDMA and cdma2000, such as flexible spectrum allocation, low-cost implementation, and easier migration from GSM systems. This article reviews the development, key technical features, and deployment of TD-SCDMA in China. [J119]

"Radar: the evolution since World War II"

Modern radar design has benefited from the evolution of specialized digital processing, allowing high resolution ground mapping, target identification, and target tracking under many conditions. Air-to-air interception makes use of complex decision processes to select from many modes that depend on the clutter backgrounds and flight profiles. Today's multimode radars provide this information for each task while minimizing distractions. Fire control radars support a wide selection of weapons, including cannons and guided missiles. This is possible because of advanced digital processing. In the interval since WW II, radar design evolved from vacuum tubes to semiconductors and then to massively integrated circuits. Computers specialized for fast Fourier transforms (FFTs) have revolutionized radar data processing. System reliability has improved from a few hours to hundreds of hours. Effective built-in test informs ground maintenance personnel of problems for easy maintenance and low failure rates reduce or eliminate field maintenance benches at forward locations. Airborne surveillance radars, such as AW ACS Joint Stars have changed the nature of warfare. Commanders have virtually full view of enemy and friendly forces. Radars, in combination with other remote sensors, provide precise weapon delivery, reducing collateral damage and making all weapons more effective [J120]

"Human-centered concepts for exploration and understanding of Earth observation images"

The progress in information retrieval, computer vision, and image analysis makes it possible to establish very complete bases of algorithms and operators. A specialist in remote sensing or image processing now has the tools that allow him, at least in theory, to configure applications solving complex problems of image understanding. However, in reality, earth observation (EO) data analysis is still performed in a very laborious

way at the end of repeated cycles of trial and error. To overcome this, we proposed a novel advanced remote sensing information processing system knowledge-driven information mining (KIM). KIM is based on human-centered concepts (HCCs), which implements new features and functions allowing improved feature extraction, search on a semantic level, the availability of collected knowledge, interactive knowledge discovery, and new visual user interfaces. We assess the HCC methodology for solving several difficult tasks in EO image interpretation, using a broad variety of sensor data, from meter-resolution synthetic aperture radar and optical images to hyperspectral data. [J121]

"Smart Phased Array SoCs: A Novel Application for Advanced SiGe HBT BiCMOS Technology"

As BiCMOS IC technology continues to advance in scaling and performance, new applications are continually enabled. One such concept is a smart phased array system on a chip (SoC). The combination of high-performance SiGe heterojunction bipolar transistor (HBT) bipolar devices, well-characterized RF/analog passive components, and dense CMOS digital technology provides the capability to create large multielement, electronically tunable phased arrays with onboard processing intelligence, inside a single die. This SoC will have superior characteristics of lower cost, weight, and size as compared to the large multichip, multitechnology, and multipackage systems in deployment today. Furthermore, using reconfigurable logic and embedded memory, this SoC has the advantage of dynamic software and digital signal processing engine updates, without expensive redesigns of the chip. This publication will describe the necessary ingredients to create such an SoC as well as relevant applications of smart phased arrays that require an SiGe HBT BiCMOS technology. Potential markets for this technology include communications systems, weather tracking, radio astronomy, automotive radar, cellular basestation capacity improvement, satellite and aerial resource imaging, ground-level airplane collision avoidance, as well as military tracking and guidance systems. [J122]

"Advanced Precipitation Radar Antenna: Array-Fed Offset Membrane Cylindrical Reflector Antenna"

As part of the overall NASA earth science technology research effort, a half-size prototype model of light-weight, dual-frequency and wide-swath scanning antenna for the next generation of spaceborne precipitation radar has recently been developed. It operates radar channels at both 13.6 and 35 GHz for improved rainfall retrieval accuracy. The antenna for proposed spaceborne precipitation radar is an offset parabolic cylindrical reflector fed by two linear arrays. This design is adopted, instead of a double-curved offset reflector, because it provides the required wide scan angle in the cross-track plane at both the Ku and Ka band operating frequencies. To demonstrate the technological readiness of the concept, the focus is on a half-scale model of 2.65 m operating at Ku and Ka band. In this paper, the technology development status on this Advanced Precipitation Radar Antenna will be presented. Design and characterization of the 2.65 m antenna is detailed by presenting the features of various components of the antenna, including simulation of the performance, 2$,times,$166 Ku and 4$,times,$166 Ka element feed array designs and evaluation and the design concept of the membrane reflector. Measurement results of the entire antenna system using a compact range facility will also be summarized. [J123]

"Multibaseline cross-track SAR interferometry: a signal processing perspective"

Synthetic aperture radar interferometry (InSAR) is a powerful and increasingly expanding technique for measuring the topography of a surface, its changes over both short- and long-time scale, and other changes in the detailed characteristics of the surface. We provide a tutorial description of recent results on multibaseline (MB) InSAR processing. The main focus is on the problem of retrieving both heights and radar reflectivities of natural layover areas by means of a cross-track InSAR (XTI-SAR) system with a uniform linear array (ULA). It is formulated as the problem of detecting and estimating a multicomponent signal corrupted by multiplicative noise-the speckle in the radar imaging jargon-and by additive white Gaussian noise. Application to the InSAR problem of both nonparametric and parametric modern spectral estimation techniques is described. The problem of estimating the number of signal components in the presence of speckle is also addressed. Finally, a brief mention is given to recent research trends on robust methods for nonperfectly calibrated arrays, on processing for non-ULA configurations, and on MB SAR tomography, which is an extension of MB SAR interferometry for the full 3D mapping of semitransparent volume scattering layers. The state of the art of other advanced multichannel interferometric techniques is also briefly recalled. [J124]

"CardioSmart: Cardiological Monitoring Intelligent system using GPRS"

This paper presents a Medicine/Engineering multidisciplinary research project, in which a European Telecardiology system has been developed for the continuing monitoring of patients using GPRS/GSM. The system consists in a portable terminal and a call center that provide 24h-duty medical supervision and

assistance. The system includes advanced signal processing for the recognition of cardiac pathologies using neural networks, compression with wavelets, encryption and GPS to locate the patient in case of fading. The main requirements for this project have been its technical and economical viability and the user's acceptance of the system. The results obtained validate the system, showing its transnational supervision and remote attendance capability. The main achievements generate ambient intelligence and can be easily applied to other telemedical fields. This research project has been partially funded by the European Union under the VFP Information Society Technologies programme (IST-2001-35073) [J125]

"Conference report-Recent advances in space technologies"

{no data available} [J126]

"Teaching ethics in the engineering design process: a legal scholar's view"

Engineering ethics are a critical "gap filler" in the regulation of technology. Engineers, as "professionals," are given professional autonomy in promoting risky activities, based on a promise that they will act in the public interest. The legal system, both in regulation and liability, puts constraints on the design process, but often leaves gaps that must be filled by ethical precepts. The conflict between the public interest and the private interest of the engineer is often most acute in the acceptance or rejection of relatively rare risks in the design of products. Rare risks normally involve the greatest uncertainty of injury. These rare risks of catastrophic injury can fall "under the radar" of regulatory systems, or technological advances may make regulatory systems obsolete. The other major risk category are "system risks," in which individual engineers assume that some other party will take care of the risk. Teaching engineers to recognize and deal with these risks is critical. In particular, reliance on regulatory approval may be inadequate. Designing products that hold paramount the public safety must be the benchmark for engineering ethics. [J127]

"On the generation of ERS/ENVISAT DInSAR time-series via the SBAS technique"

We exploit the small baseline subset (SBAS) algorithm for generating deformation time-series from SAR data acquired by sensors with different characteristics but with the same illumination geometry. In particular, our approach is focused on the use of European Remote Sensing (ERS) and ENVISAT satellite data, the latter acquired by the Advanced Synthetic Aperture Radar sensor on the IS2 swath. The proposed solution is oriented to investigate large-scale displacements with a relatively low spatial resolution (about 100Ч100 m) and implements an easy but effective combination of ERS and ENVISAT multilook interferograms which benefits of the temporal overlap between the acquisitions of the two sensors. Moreover, the algorithm does not rely on specific hypothesis on the spatial or temporal characteristics of the investigated deformations. Presented results, achieved on a synthetic aperture radar dataset relevant to the Napoli city area (Italy), confirm the validity of the approach. [J128]

"An advanced system for the automatic classification of multitemporal SAR images"

A novel system for the classification of multitemporal synthetic aperture radar (SAR) images is presented. It has been developed by integrating an analysis of the multitemporal SAR signal physics with a pattern recognition approach. The system is made up of a feature-extraction module and a neural-network classifier, as well as a set of standard preprocessing procedures. The feature-extraction module derives a set of features from a series of multitemporal SAR images. These features are based on the concepts of long-term coherence and backscattering temporal variability and have been defined according to an analysis of the multitemporal SAR signal behavior in the presence of different land-cover classes. The neural-network classifier (which is based on a radial basis function neural architecture) properly exploits the multitemporal features for producing accurate land-cover maps. Thanks to the effectiveness of the extracted features, the number of measures that can be provided as input to the classifier is significantly smaller than the number of available multitemporal images. This reduces the complexity of the neural architecture (and consequently increases the generalization capabilities of the classifier) and relaxes the requirements relating to the number of training patterns to be used for classifier learning. Experimental results (obtained on a multitemporal series of European Remote Sensing 1 satellite SAR images) confirm the effectiveness of the proposed system, which exhibits both high classification accuracy and good stability versus parameter settings. These results also point out that properly integrating a pattern recognition procedure (based on machine learning) with an accurate feature extraction phase (based on the SAR sensor physics understanding) represents an effective approach to SAR data analysis. [J129]

"Road-boundary detection and tracking using ladar sensing"

Road-boundary detection is an integral and important function in advanced driver-assistance systems and autonomous vehicle navigation systems. A prominent feature of roads in urban, semi-urban, and similar

environments, such as in theme parks, campus sites, industrial estates, science parks, and the like, is curbs on either side defining the road's boundary. Although vision is the most common and popular sensing modality used by researchers and automotive manufacturers for road-lane detection, it can pose formidable challenges in detecting road curbs under poor illumination, bad weather, and complex driving environments. This paper proposes a novel method based on extended Kalman filtering for fast detection and tracking of road curbs using successive range/bearing readings obtained from a scanning two-dimensional ladar measurement system. As compared with millimeter wave radar methods reported in the literature, the proposed technique is simpler and computationally more efficient. This is the first of its kind reported in the literature. Qualitative experimental results are presented from the application of the technique to a campus site environment to demonstrate the viability, effectiveness, and robustness. [J130]

"High power keeps cool"

Advanced U.S. Department of Defense (DoD) surveillance sensors are continually pushing the need for ever-increasing electronics performance. Full-time, large-area ground surveillance capability, for instance, has been proven to be of great importance in recent conflicts; it drives the requirement for the signal processing of growing numbers of radar channels with increasing bandwidth. At the same time, the surveillance platforms carrying these sensors, typified by unmanned aerial vehicles (UAVs) or other small aircraft or spacecraft, are being pushed to be smaller, lighter, cheaper, and to have longer mission durations. [J131]

"Multibaseline ATI-SAR for robust ocean surface velocity estimation"

An open problem of along-track interferometry (ATI) for synthetic aperture radar (SAR) sensing of ocean surface currents is the need of ancillary wind information for inversion of Doppler centroid measurements, that have to be compensated for the propagation velocity of advancing and/or receding Bragg scatterers. We propose three classes of estimators which exploit multibaseline (MB) ATI acquisition and Doppler resolution for robust data inversion under different degrees of a priori information about the wind direction and the value of the characteristic Bragg frequency. Performance analysis and comparison with conventional ATI show that the proposed MB estimators can produce accurate velocity estimates in the absence of detailed ancillary data. [J132]

"A geometric performance assessment of the EO-1 advanced land imager"

The Earth Observing 1 (EO-1) Advanced Land Imager (ALI) demonstrates technology applicable to a successor system to the Landsat Thematic Mapper series. A study of the geometric performance characteristics of the ALI was conducted under the auspices of the EO-1 Science Validation Team. This study evaluated ALI performance with respect to absolute pointing knowledge, focal plane sensor chip assembly alignment, and band-to-band registration for purposes of comparing this new technology to the heritage Landsat systems. On-orbit geometric calibration procedures were developed that allowed the generation of ALI geometrically corrected products that compare favorably with their Landsat 7 counterparts with respect to absolute geodetic accuracy, internal image geometry, and band registration. [J133]

"Airborne high-resolution ISAR imaging of ship targets at sea"

We address the problem of airborne high resolution two-dimensional inverse synthetic aperture radar (ISAR) side-view imaging of ship targets. Using a simple model of the ship motions avoids the use of advanced joint-time frequency (JTF) transforms. A robust processing scheme including motion estimation and correction, optimal processing time and duration estimation and target shape extraction are developed. We stress the fact that the robustness of this processing leads to a single ISAR image analysis and that no merging of data from a set of radar images is necessary. [J134]

"Programmable ultrawideband signal generator for electromagnetic susceptibility testing"

Under Phase I of the Defense Advanced Research Projects Agency (DARPA) Networking in Extreme Environments (NETEX) initiative, Multispectral Solutions, Inc. (MSSI) was tasked with the development of a general-purpose, ultrawideband hardware simulator capable of reproducing a wide variety of ultrawideband (UWB) waveforms. The simulator, with UWB outputs from baseband through millimeter wave, was to be used for the purpose of electromagnetic susceptibility testing of legacy military radio, radar, and positioning systems. The ultimate goal of this portion of the Phase I program was the quantitative determination of those UWB parameters (e.g., frequency, power, pulse rate, pulse shape, dithering, etc.) which had the least impact on the operational performance of legacy designs. This describes the development of the MSSI NETEX UWB simulator (BFP1000). [J135]

"ARKTOS: an intelligent system for SAR sea ice image classification"

We present an intelligent system for satellite sea ice image analysis named Advanced Reasoning using Knowledge for Typing Of Sea ice (ARKTOS). ARKTOS performs fully automated analysis of synthetic aperture radar (SAR) sea ice images by mimicking the reasoning process of sea ice experts. ARKTOS automatically segments a SAR image of sea ice, generates descriptors for the segments of the image, and then uses expert system rules to classify these sea ice features. ARKTOS also utilizes multisource data fusion to improve classification and performs belief handling using Dempster-Shafer. As a software package, ARKTOS comprises components in image processing, rule-based classification, multisource data fusion, and graphical user interface-based knowledge engineering and modification. As a research project over the past ten years, ARKTOS has undergone phases such as knowledge acquisition, prototyping, refinement, evaluation, deployment, and operationalization at the U.S. National Ice Center. In this paper, we focus on the methodology, evaluations, and classification results of ARKTOS. [J136]

"Ultra-wideband communications: an idea whose time has come"

Ultra-wideband (UWB) radio is a fast emerging technology with many unique attractive features that promotes major advances in wireless communications, networking, radar, imaging, and positioning systems. Research in UWB is still in its infancy stages, offering limited resources in handling the challenges facing the UWB communications. Understanding the unique properties and challenges of UWB communications as well as its application in competent signal processing techniques are vital in conquering the obstacles towards developing exciting UWB applications. UWB research and development has to cope with the challenges that limit their performance, capacity, throughput, network flexibility, implementation complexity, and cost. This tutorial focuses on UWB wireless communications at the physical layer. It overviews the state-of-the-art UWB in channel modeling, transmitters, and receivers of UWB radios, and outlines the research directions and challenges that needs to be overcome. Since a signal processing expertise is expected to have major impact in research and development of UWB systems, emphasis is placed on the DSP aspects. [J137]

"In-flight validation and recovery of water surface temperature with Landsat-5 thermal infrared data using an automated high-altitude lake validation site at Lake Tahoe"

The absolute radiometric accuracy of the thermal infrared band (B6) of the Thematic Mapper (TM) instrument on the Landsat-5 (L5) satellite was assessed over a period of approximately four years using data from the Lake Tahoe automated validation site (California-Nevada). The Lake Tahoe site was established in July 1999, and measurements of the skin and bulk temperature have been made approximately every 2 min from four permanently moored buoys since mid-1999. Assessment involved using a radiative transfer model to propagate surface skin temperature measurements made at the time of the L5 overpass to predict the at-sensor radiance. The predicted radiance was then convolved with the L5B6 system response function to obtain the predicted L5B6 radiance, which was then compared with the radiance measured by L5B6. Twenty-four cloud-free scenes acquired between 1999 and 2003 were used in the analysis with scene temperatures ranging between 4°C and 22°C. The results indicate L5B6 had a radiance bias of 2.5% (1.6°C) in late 1999, which gradually decreased to 0.8% (0.5°C) in mid-2002. Since that time, the bias has remained positive (predicted minus measured) and between 0.3% (0.2°C) and 1.4% (0.9°C). The cause for the cold bias (L5 radiances are lower than expected) is unresolved, but likely related to changes in instrument temperature associated with changes in instrument usage. The in situ data were then used to develop algorithms to recover the skin and bulk temperature of the water by regressing the L5B6 radiance and the National Center for Environmental Prediction (NCEP) total column water data to either the skin or bulk temperature. Use of the NCEP data provides an alternative approach to the split-window approach used with instruments that have two thermal infrared bands. The results indicate the surface skin and bulk temperature can be recovered with a standard error of 0.6°C. This error is larger than errors obtained with other instruments due, in part, to the calibration bias. L5 provides the only long-duration high spatial resolution thermal infrared measurements of the land surface. If these data are to be used effectively in studies designed to monitor change, it is essential to continue to monitor ins- trument performance in-flight and develop quantitative algorithms for recovering surface temperature. [J138]

"Electron density profile measurement using an ultrashort-pulsed radar reflectometer on large helical device"

We have installed a six channel ultrashort-pulsed radar reflectometer system on the large helical device and performed electron density profile measurements. The delay time of the reflected pulses from each cutoff layer in the plasma is measured by a time-of-flight measurement technique in order to avoid the mixture of radiation effects and spurious reflections. The electron density profile is reconstructed using an Abel inversion method from the profile of the delay time as a function of the probing frequency. The reconstructed density profile is compared with the profile measured with the far-infrared (FIR) interferometer. It is found that the arrival time of

each reflected pulse differs from the estimated time measured with the FIR interferometer. [J139]

"The hydrosphere State (hydros) Satellite mission: an Earth system pathfinder for global mapping of soil moisture and land freeze/thaw"

The Hydrosphere State Mission (Hydros) is a pathfinder mission in the National Aeronautics and Space Administration (NASA) Earth System Science Pathfinder Program (ESSP). The objective of the mission is to provide exploratory global measurements of the earth's soil moisture at 10-km resolution with two- to three-days revisit and land-surface freeze/thaw conditions at 3-km resolution with one- to two-days revisit. The mission builds on the heritage of ground-based and airborne passive and active low-frequency microwave measurements that have demonstrated and validated the effectiveness of the measurements and associated algorithms for estimating the amount and phase (frozen or thawed) of surface soil moisture. The mission data will enable advances in weather and climate prediction and in mapping processes that link the water, energy, and carbon cycles. The Hydros instrument is a combined radar and radiometer system operating at 1.26 GHz (with VV, HH, and HV polarizations) and 1.41 GHz (with H, V, and U polarizations), respectively. The radar and the radiometer share the aperture of a 6-m antenna with a look-angle of 39° with respect to nadir. The lightweight deployable mesh antenna is rotated at 14.6 rpm to provide a constant look-angle scan across a swath width of 1000 km. The wide swath provides global coverage that meet the revisit requirements. The radiometer measurements allow retrieval of soil moisture in diverse (nonforested) landscapes with a resolution of 40 km. The radar measurements allow the retrieval of soil moisture at relatively high resolution (3 km). The mission includes combined radar/radiometer data products that will use the synergy of the two sensors to deliver enhanced-quality 10-km resolution soil moisture estimates. In this paper, the science requirements and their traceability to the instrument design are outlined. A review of the underlying measurement physics and key instrument performance parameters are also presented. [J140]

"Stochastic H∞ tracking with preview for state-multiplicative systems"

The problem of finite-horizon H∞tracking for linear time-varying systems with stochastic parameter uncertainties is investigated. We consider three tracking patterns depending on the nature of the reference signal, i.e., whether it is perfectly known in advance, measured on line or previewed in a fixed time-interval ahead. The stochastic uncertainties appear in both the dynamic and measurement matrices of the system. For each of the above three cases a game theory approach is applied for the state-feedback case where, given a specific reference signal, the controller plays against nature which chooses the initial condition and the energy-bounded disturbance. The problems are solved using an expected value of the standard performance index over the stochastic parameters, where necessary and sufficient conditions are found for the existence of a saddle-point equilibrium. The infinite-horizon time-invariant tracking problem is also solved. The theory developed is demonstrated by a simple tracking example. [J141]

"Low probability of intercept radar strategies"

To reduce probability of intercept, in most cases, the form and magnitude of the radar transmissions are designed to spread energy over as wide a range of dimensions as possible. Equally, in response to this, designs for electronic surveillance measures (ESM) systems have been postulated that increase receiver sensitivity. Their purpose is to increase detection range beyond that of the radar (or to an adequate range if they are to be forward deployed). The authors examine the evolving nature of the relationship between advanced 'low probability of intercept' (LPI) radar designs and future trends in ESM receiving capability. This relationship is far from straightforward, being both probabilistic and dependent on environmental and operational factors. Indeed this is complicated still further by the issue of affordability. The authors compute the performance of ESM and radar systems for a number of cases, including not just simple interception, but also the extraction of information from intercepted signals. In this way the key factors influencing the detectability of LPI radar systems are determined. It is demonstrated that it is never possible to be completely certain that a radar system has not been detected and that the most appropriate way to implement an LPI radar design is always closely related to the tactical environment in which the radar system will be used. Indeed this often overrides the technical aspects of system performance. [J142]

"A progressive morphological filter for removing nonground measurements from airborne LIDAR data"

Recent advances in airborne light detection and ranging (LIDAR) technology allow rapid and inexpensive measurements of topography over large areas. This technology is becoming a primary method for generating high-resolution digital terrain models (DTMs) that are essential to numerous applications such as flood modeling and landslide prediction. Airborne LIDAR systems usually return a three-dimensional cloud of point

measurements from reflective objects scanned by the laser beneath the flight path. In order to generate a DTM, measurements from nonground features such as buildings, vehicles, and vegetation have to be classified and removed. In this paper, a progressive morphological filter was developed to detect nonground LIDAR measurements. By gradually increasing the window size of the filter and using elevation difference thresholds, the measurements of vehicles, vegetation, and buildings are removed, while ground data are preserved. Datasets from mountainous and flat urbanized areas were selected to test the progressive morphological filter. The results show that the filter can remove most of the nonground points effectively. [J143]

"Into digital computing through the back door"

From a hazy dream of writing a great American novel to heading up the renowned Lockheed Skunk Works, Sherman Mullin explains how he came to be an engineer-in digital computing, moreover, when the rest of the world was still mostly analog. Like most people who entered the digital computing field in the 1950s, he had no formal education in this technology. Like others, he learned mostly by doing. He began with the US Air Force, then moved to the Burroughs Corporation in Philadelphia. He progressed through various jobs and ended up as president of Lockheed Advanced Development Company. [J144]

"Air Force Research Laboratory advanced compact range RCS uncertainty analysis for a general target"

A calibration uncertainty analysis was conducted for the Air Force Research Laboratory's (AFRL's) Advanced Compact Range (ACR) in 2000. This analysis was a key component of the Radar Cross Section (RCS) ISO-25 (ANSI-Z-540) Range Certification Demonstration Project. The scope of the RCS uncertainty analysis for the demonstration project-was limited to calibration targets. Since that time, we have initiated a detailed RCS uncertainty analysis for a more-typical target measured in the ACR. A "more typical" target is one that is much larger with respect to a wavelength than the calibration targets, and that is characterized by a wide dynamic range of RCS scattering levels. We chose a 10-foot ogive as the target, due to the fact it was a large target, exhibited a wide dynamic range of scattering, and the scattering levels could be predicted using readily available CEM codes. We present the methodology for the uncertainty analysis and detailed analyses of selected component uncertainties. The aspects of the uncertainty analysis that are unique to the "typical target" (i.e., a non-calibration target) are emphasized. [J145]

"Reflectivity estimation for multibaseline interferometric radar imaging of layover extended sources"

In recent years, there has been great interest in exploiting the advanced multibaseline operation of synthetic aperture radar interferometry (InSAR) for solving layover effects from complex orography, which can degrade both SAR and InSAR imagery of terrain radar reflectivity and height. In this work, the problem of retrieving radar reflectivity of layover areas is addressed. It is formulated as the problem of estimating a multicomponent sinusoidal signal corrupted by multiplicative complex correlated noise and additive white Gaussian noise. Application of nonparametric [e.g., Capon, amplitude and phase estimation filter (APES)], parametric [least squares, modern parametric RELAXation spectral estimator (RELAX)], and hybrid spectral estimators for amplitude estimation is investigated for a multilook scenario. In particular, the multilook extensions of RELAX and APES are applied to the interferometric problem. Performance analysis is investigated through a Cramer-Rao lower bound calculation and Monte Carlo simulation. The method of least squares, coupled with Capon's approach to spatial frequency estimation, multilook APES, and multilook RELAX turn out to provide accurate reflectivity estimates for undistorted multibaseline image formation of layover areas. [J146]

"Evolution of the DOD microwave and millimeter wave monolithic IC program"

The Department of Defense (DOD) Microwave and Millimeter Wave Monolithic Integrated Circuit Program was the culmination of advances in materials research, semiconductor physics, transmission media, modeling and simulation, device development, and manufacturing process development stemming from research conducted prior to and during World War II. Conducted in the 1980s and 1990s, MIMIC's objective was to achieve compact, low-cost, and highly reliable millimeter and microwave circuit functions that could withstand extreme environments in weapon systems. The program provided a. unique architecture in which goals were framed in system terms to provide the linking mechanism between materials research, device design, modeling, simulation, and testing. The program can be applied to four major areas of high technology: radar, communications, countermeasures, counter-countermeasures, and smart weapons. Economy was achieved by fabricating both the active and passive-circuit functions and interconnections in monolithic form in semiinsulating gallium arsenide wafers. When the program was being formulated in 1986, the market was principally military, but when it ended in 1995, the market was primarily commercial. Success of the MIMIC Program makes it a useful model for the design of other programs to achieve national objectives for defense or to improve competitiveness in international

markets. The objective of this paper is to define the global environment in which the program was planned, and to identify the elements that made it successful and therefore a valuable model, for public and private sector collaboration. [J147]

"NASA advances robotic space exploration"

NASA's successful exploration of space has uncovered vast amounts of new knowledge about the Earth, the solar system and its other planets, and the stellar spaces beyond. To continue gaining new knowledge has required-and will continue to require-new capabilities in onboard processing hardware, system software, and applications such as autonomy. For example, initial robotic space exploration missions functioned, for the most part, as large flying cameras. These instruments have evolved over time to include more sophisticated imaging radar, multispectral imagers, spectrometers, gravity wave detectors, a host of prepositioned sensors and, most recently, rovers. [J148]

"Real-time digital signal processing of phased array radars"

With the advance of hardware and software technology, modern phased array radars are now built with commercial-off-the-shelf (COTS) components, and it opens up a new era in real-time resource scheduling of digital signal processing. This paper targets the essential issues in building a component-oriented signal processor (SP), which is one of the two major modules in modern phased array radars. We propose a simple but effective task allocation policy and a real-time scheduling algorithm to address the design objectives of SPs. We are able to bound the number of processing units needed for a component-oriented SP in the design time, while everything was done empirically in the past. A series of experiments was done to demonstrate the strength of our methodology. [J149]

"Expanded Swerling target models"

Radar target fluctuation models were first introduced by Swerling in the 1950s and they proved to be very useful. Swerling soon realized, however, that his original four models were inadequate and generalized them through use of the gamma distribution. These generalized results still had serious limitations in modeling fluctuating targets. For some targets the Swerling I correlated model produced an overly pessimistic value for PDat large signal-to-noise ratios (SNRs) while the Swerling III correlated model produced an overly optimistic one. As a result, other fluctuation models, such as the log-normal and Weibull, remain useful in spite of their own limitations. Two new models that expand on the generalized Swerling model are presented here. They are physically motivated and can produce the desired PDlevels at high SNR values. They are described in detail and both the moment generating functions (MGFs) and PDexpressions are determined. They provide a significant advance in our modeling capabilities through their flexibility for modeling many different types of target radar cross section (RCS) responses. These new models apply to both the case where the pulse-to-pulse target responses are correlated as well as the case where they are uncorrelated, thereby overcoming the limitations of the log-normal and Weibull models. [J150]

"Automatic spectral target recognition in hyperspectral imagery"

Automatic target recognition (ATR) in hyperspectral imagery is a challenging problem due to recent advances of remote sensing instruments which have significantly improved sensor's spectral resolution. As a result, small and subtle targets can be uncovered and extracted from image scenes, which may not be identified by prior knowledge. In particular, when target size is smaller than pixel resolution, target recognition must be carried out at subpixel level. Under such circumstance, traditional spatial-based image processing techniques are generally not applicable and may not perform well if they are applied. The work presented here investigates this issue and develops spectral-based algorithms for automatic spectral target recognition (ASTR) in hyperspectral imagery with no required a priori knowledge, specifically, in reconnaissance and surveillance applications. The proposed ASTR consists of two stage processes, automatic target generation process (ATGP) followed by target classification process (TCP). The ATGP generates a set of targets from image data in an unsupervised manner which will subsequently be classified by the TCP. Depending upon how an initial target is selected in ATGP, two versions of the ASTR can be implemented, referred to as desired target detection and classification algorithm (DTDCA) and automatic target detection and classification algorithm (ATDCA). The former can be used to search for a specific target in unknown scenes while the latter can be used to detect anomalies in blind environments. In order to evaluate their performance, a comparative and quantitative study using real hyperspectral images is conducted for analysis. [J151]

"Evidence for viscosity, thermal conduction and diffusion waves in the Earth's atmosphere (invited)"

Over the last 40 years, radar studies of atmospheric backscatter have shown tantalizing evidence for flat, mirror-

like partial reflectors embedded in the air. These have been observed at all heights, but especially in the stratosphere (above 10 km) and mesosphere (especially in the region 60-90 km altitude), and at a variety of frequencies, from 2 to at least 50 MHz. These structures appear to have vertical depths of only a few meters or less. They often seem independent of atmospheric turbulence scatter. Various explanations have been advanced to account for these unusual structures, but a strong candidate is the possibility that they are due to diffusion waves generated by reflection and/or critical level interactions of gravity waves or infrasound. In this review, we will examine the evidence for these structures, and expand on the possibility that they are indeed organized structures which develop due to the diffusive characteristics of the medium. copyright 2003 American Institute of Physics. [J152]

"Project54: standardizing electronic device integration in police cruisers"

Technological advances have introduced many electronic devices into police cruisers. Today's police cruisers are equipped with not only lights and sirens but also digital radios, GPS units, computers, radars, and other devices. These in-car devices aren't usually designed with integration in mind. This design approach creates two problems. The first stems from the fact that police cruisers are primarily vehicles and the officers operating them are primarily drivers. Because in-car devices aren't designed for integration, most police departments install them in cruisers as stand-alone devices, each with its own user interface. Consequently, the officers operating the cruisers must deal with the distraction of interacting with multiple user interfaces in the hands- and eyes-busy environment of a car. Research shows that interacting with even a single in-car device can lead to safety problems. Interacting with multiple in-car devices clearly poses a safety problem. This problem is likely to worsen as new devices are installed in cruisers. [J153]

"Passive millimeter wave imaging"

This article introduces the concept of passive millimeter-wave (PMMW) imaging, describes the phenomenology that defines its performance, explains the technology advances that have made these systems a reality, and presents some of the missions in which these sensors can be used. [J154]

"Enhancing homeland security with advanced UWB sensors"

This article discusses recent research into short-range UWB radars that have the potential to create more robust perimeter security sensor systems for exterior installations. It also briefly discusses existing UWB sensors to show how they establish a technical precedent for today's research. [J155]

"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 [J156]

"Increasing airport efficiency: injecting new technology"

Advanced surface movement guidance and control systems (A-SMGCS)-called airport surface detection equipment in North America-can potentially solve the airport capacity bottleneck while maintaining at least the current safety level. A-SMGCS are becoming increasingly sophisticated and play a major role in avoiding runway incursions. To investigate the feasibility of phasing in new technology to ease airport operations, the European Commission has funded several research projects. The latest project, called VISION (improVed aIrport A-SMGCS by integrated multisensor data fuSION), aims to apply all the technologies developed in previous projects, including A-SMGCS, to a set of real airports. [J157]

"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 [J158]

"Maximum likelihood angle extractor for two closely spaced targets"

In a scenario of closely spaced targets special attention has to be paid to radar signal processing. We present an advanced processing technique, which uses the maximum likelihood (ML) criterion to extract from a monopulse radar separate angle measurements for unresolved targets. This processing results in a significant improvement, in terms of measurement error standard deviations, over angle estimators using the monopulse ratio. Algorithms are developed for Swerling I as well as Swerling III models of radar cross section (RCS) fluctuations. The accuracy of the results is compared with the Cramer Rao lower bound (CRLB) and also to the monopulse ratio technique. A novel technique to detect the presence of two unresolved targets is also discussed. The performance of the ML estimator was evaluated in a benchmark scenario of closely spaced targets-closer than half power beamwidth of a monopulse radar. The interacting multiple model probabilistic data association (IMMPDA) track estimator was used in conjunction with the ML angle extractor [J159]

"Building safer cars"

In the future, cars will help make the world's roads nearly accident free. Humans are fallible: we get sleepy while driving at night, do dumb things like put on makeup or shave while creeping along in bumper-to-bumper traffic, or look away from the road to adjust our car radios. But cars will soon make road travel safer by looking over drivers' shoulders, so to speak, keeping their attention from being pulled away from the road, and finding ways to reduce the hazard should a driver's focus stray. To this end, researchers envision smart systems that give the driver "the right information, in the right way, at the right time". R&D programs are advancing toward a smart car capable of reducing the number of stimuli, some of them simultaneous, to which a driver must react, or taking over elements of the driving task such as braking or steering. Adaptive cruise control (ACC) systems are being developed which combine radar- or laser-based sensors that scan the road ahead with throttle and brake actuators, to maintain a safe, preset minimum distance between cars in the same lane [J160]

"Coherent integration of 0.5 GHz spectral holograms at 1536 nm using dynamic biphase codes"

Spectral hole-burning-based optical processing devices are proposed for coherent integration of multiple high-bandwidth interference patterns in a spectral hole-burning medium. In this implementation, 0.5 GHz spectral holographic gratings are dynamically accumulated in Er3+:Y2SiO5at 4.2 K using a 1536 nm laser frequency stabilized to a spectral hole, along with commercial off-the-shelf components. The processed data, representing time delays over 0.5-2.0 mu s, were optically read out using a frequency-swept probe; this approach makes possible the use of low-bandwidth, large-dynamic-range detectors and digitizers and enables competitive processing for applications such as radar, lidar, and radio astronomy. Coherent integration dynamics and material advances are reported. copyright 2002 American Institute of Physics. [J161]

"Opportunities in radar-2002"

This paper addresses some of the potential opportunities for achieving advances in radar systems and technology. It is not a summary of current interests in radar, nor is it a forecast of what 'will be', but is speculation about what 'could be' based on the limited experiences and personal biases of the writer. Included are the replacement of existing radars that have been in use for some time, 'on-the-shelf' concepts and demonstrated technology that have yet to be employed, a few new directions that might offer capabilities that do not currently exist, and areas of basic technology that could be further explored to provide new understanding and new capabilities. Although much is included in the paper, it is not meant to be an exhaustive enumeration of

the many possible directions for future radar. [J162]

"Medium PRF set selection using evolutionary algorithms"

This paper presents a new and novel method of selecting multiple pulse repetition frequency (PRF) sets for use in medium PRF pulsed-Doppler radars. Evolutionary algorithms are used to minimise the blind areas in the range/Doppler space. The evolutionary algorithm allows optimal solutions to be generated quickly, far faster than with exhaustive searches, and is fully automatic, unlike existing techniques. The evolved solutions compare very favorably against the results of both an exhaustive search and existing published PRF set selection methods. This evolutionary approach to generation of PRF sets is a major advance in medium PRF radar design. [J163]

"Opening eyes: building company-wide IT security awareness"

Managing IT system security is a never-ending effort. Regardless of how well you secure a system today, new threats and issues will appear tomorrow. User support, IT staff enthusiasm, and management buy-in are critical assets for overcoming the constant barrage of threats. Unfortunately, there is no standard playbook that tells IT managers how to manage these relationships and focus them on security issues. Every IT staff must build its own strategy. The article outlines concepts to manage security. This list serves as a good source of ideas for how IT managers can use awareness to advance their security goals [J164]

"The use of laminate multichip modules for the packaging of 9-GHz digital multichip circuits"

An investigation of the high-frequency performance of laminate multichip module (MCM-L) technology was undertaken with the goal of demonstrating its appropriateness for the development of digital radar receivers operating in the X band (8 to 12 GHz). A seven-chip circuit using digital components on a Gore MCM-L was successfully tested up to 9.6 GHz. An analog-to-digital converter on an MCM-L was successfully tested up to 6 GHz. An extensive characterization of the MCM-L technology using both simulations and measurements was performed to formulate a set of design guidelines for high-frequency applications. A novel dielectric-encapsulated MCM-to-MCM interconnect scheme was proposed and tested [J165]

"Senrad: an advanced wideband air-surveillance radar"

The generic characteristics and performance of an experimental long-range air-surveillance radar, known at the Naval Research Laboratory as Senrad, is described. Its distinguishing feature is that it can operate with simultaneous transmissions over a very wide bandwidth-from 850 to 1400 MHz. The technology and type of experimental radar equipment employed are discussed and examples are given of its performance capabilities obtained by means of very wideband operation. The unusually wide bandwidth of this radar allows 1) improved detection and tracking performance because of the absence of the nulls that are common in the antenna elevation radiation-pattern of a single-frequency radar; 2) moving target indication (MTI) without loss of targets due to blind speeds and without the need for multiple PRFs (pulse repetition frequencies); 3) accurate height finding with a fan-beam radar by taking advantage of the multipath time difference as a function of target height; 4) a form of limited target recognition based on high range-resolution; and 5) a reduction of the effectiveness of electronic countermeasures that can seriously degrade more narrowband radars [J166]

"The state-of-the-art of GaAs and InP power devices and amplifiers"

Significant investments and R&D efforts over the past two decades have established GaAs and InP electronic device technologies from substrate manufacturing to MMIC amplifier design and testing. Today, GaAs and InP HBTs and HFETs, as far as gain, efficiency, and power are concerned, dominate the whole spectrum from S- to W-band and beyond. In this paper we discuss recent advances in device technologies and survey the state of the art performance of GaAs and InP HFETs and HBTs [J167]

"Cryogenic high-Q microwave resonators for stable oscillators"

Cryogenic microwave resonators have a strong potential as frequency stabilising elements for oscillators to be used in advanced radar systems and high-bitrate microwave communication links. Depending on frequency, either 2D planar HTS-resonators, HTS-shielded sapphire TE 011resonators or cryogenic sapphire whispering-gallery mode resonators represent the best compromise between resonator quality factor and size. We have built and tested an all-cryogenic oscillator based on a WG-resonator at f=23 GHz. Phase noise measurements indicate values superior to quartz stabilized oscillators. A two-step electric frequency tuning consisting of an integrated varactor phase shifter and a dielectric plunger moved by a piezomechanical transducer is introduced to compensate frequency drifting with temperature. For further improvement of long-time frequency stability we have developed rutile-sapphire composite dielectric resonators. Due to the opposite sign of the temperature

slope of the dielectric constant of sapphire and rutile a turning point appears in the temperature dependence of the resonance frequency. Employing a moderate temperature stabilization as good as a few millikelvin around the turning point at T=78 K, we have demonstrated a long time frequency stability at least as good as for oven controlled quartz oscillators [J168]

"Global snow cover monitoring with spaceborne Ku -band scatterometer"

This paper presents a study to demonstrate the potential of a spaceborne Ku-band scatterometer to monitor global snow cover. Global Ku-band data were acquired by the NASA Scatterometer (NSCAT) operated on the Advanced Earth Observing Satellite (ADEOS) from September 1996 to June 1997. NSCAT backscatter patterns aver the northern hemisphere reveals boundaries between different snow classes, defined by the Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH, snow classification system at different times of the snow season. They show the evolution of the backscatter signature throughout the entire seasonal snow cycle. Within the snow extent determined by the National Oceanic and Atmospheric Administration (NOAA), Washington, DC, and Climate Prediction Center (CPC), operational snow product, Ku-band backscatter data expose detailed features and rapid changes as observed in in-situ snow depth data from surface weather stations in U.S., Canada, and Russia. Sensitivity of Ku-band backscatter to snow conditions is illustrated with the dramatic change over the U.S. northern plains and the Canadian prairie region corresponding to the snow event leading to the 1997 Flood of the Century. They discuss snow field experiments and data analysis plan to understand snow scattering mechanisms, to interpret snow backscatter, and to derive its relationship with snow physical parameters [J169]

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