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ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 18-2/1

“Radar Target Detection”
(«Обнаружение РЛ целей»)

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"Research on the Interference Cancelation in SFN Based Passive Radar"

It is important to get a high-quality reference signal for the cancellation and correlation detection in passive radar. The single frequency network (SFN) configuration of transmitters will cause the interference in the reference channel. The infinite impulse response filter based on the normalized least mean square rule (IIR_NLMS) can improve the cancellation gain and signal noise ratio (SNR) of the target echo, but it has limited capability in suppressing co-channel interference. In order to solve this problem, a type of equalization filter is proposed, and then combining with the IIR_NLMS filter, the equalization IIR_NLMS filter is obtained. Simulation results verify the efficiency of the algorithm. [C1]

"Detection Algorithm of Laser Radar Target Based on Wavelet Transform"

Given the different transmission characteristics under the wavelet transform (WT) domain and the different distribution characteristics of frequency domain of the signal and noise, a novel approach for detecting laser radar target based on wavelet transform has been proposed. Usually, wavelet decomposition has been used to de-noise a digital signal corrupted by noise. In our approach, we applied the wavelet decomposition and modulus maximum detect the locations of laser radar echo signal. Simulations show that the proposed algorithms are more efficient than only utilizing wavelet decomposition in a big clutter background. [C2]

"Tracking a moving target in wireless sensor networks using PDR sensors"

The Pulse-Doppler radar (PDR) is an ultrawideband radar system capable of not only detecting target location, but also measuring its radial velocity by using the Doppler Effect. However, the traditional radar signal processing techniques are mismatch with the limit computational and storage resources available on typical wireless sensor mote. In this paper, we explore the compatibility of PDRs and mote-class wireless sensor nodes by designing a new tracking system that utilizes small PDRs as sensor nodes. The system consists of several PDR sensor nodes to detect the presence and position of a moving target, a base-station node to collect the detecting data of sensor nodes, and an algorithm to estimate the location of the target from aggregated data. Our experiments which were taken place outdoor (real environment) show that the proposed system performed well to track moving objects with the average deviation error down to 0.18m. [C3]

"The Impact of High-Order Phase in Ballistic Missiles Detection"

According to characteristic of ballistic missiles and their velocity, acceleration and jerk in radar echo, we establish the echo signal model with high-order phase echo signal characteristics, then analyze the target detection performance by numerical simulation to get the relationship among the optimal number of pulses, signal-to-noise ratio and jerk. Finally, the simulations verify the principle of the method is correct and can provide guidance for practical applications. [C4]

"Ship Detection after Removal of Ambiguities by Using PolSAR Images"

Ambiguities in SAR image are very common phenomena. For maritime applications, as the high intensities of the ambiguities in low radar backscatter background of sea environments, they can be mistaken as targets and cause false alarms in ship detection. Thus, through the analysis of polarimetric characteristics of ships and ambiguities, we propose a ship detection method which applies the eigenvalue to differentiating the ship target and azimuth ambiguities. One set of Cband JPL AIRSAR polarimetric data covered Kojimawan Bay, Japan has been chosen to evaluate the method that can effectively remove false alarms caused by the azimuth ambiguities. [C5]

"Airport Detection in SAR Image Based on Perceptual Organization"

Being one of the key transportation targets, airport detection is of great importance in military and civil

applications. In this paper we propose a new method based on perceptual organization for airport detection in large SAR image. Since the runways are the most obvious characteristic of the airport, we first design belief functions for the runway features, which include collinearity, proximity, width and texture similarity. Then we propose to use the DS-evidence theory for the fusion of all belief functions, which can serve as a criterion to decide whether the two region units can be grouped. The candidate airport can be found by grouped region growing and detected by airport knowledge. Experimental results showed the effectiveness of the proposed approach for airport detection in large complex SAR image. [C6]

"Performance of Localization Algorithm under Corrupted Measurement Data and Lopsided Sensor Arrangement"

Radar networks show an interesting potential for safety and comfortable applications such as indoor monitoring or short-range automotive monitoring system. This paper presents our novel estimation algorithm of a target position. Especially we evaluate the performance about estimation accuracy and resistance to ghost targets under multipath environment. In above applications, the robust estimation is needed because the receivers tend to output corrupted measurement data. The corrupted data are mostly generated by multipath, sensitivity of receivers. Moreover, our arrangement of radars is one-side watching for easy fitting in typical applications. As a result of computer simulations, our algorithm has fine accuracy and robust detections compared with a popular trilateration algorithm. And the relationship between the estimation accuracy and the arrangement of receivers is introduced. [C7]

"A Novel Polarimetric CFAR Target Detection Method"

A new polarimetric synthetic aperture radar (PolSAR) image CFAR target detector is proposed in this paper. By introducing the inverse Gamma distribution which is extensively used in modeling, the distribution of polarimetric matched filter (PMF) metric, denoted as P_G0, is derived on the product model; Furthermore, a fast and exact parameter estimation method of P_G0distribution is presented using the "second kind statistics" based on the Mellin transform; Finally the formula of the CFAR detection threshold is deduced, and the target detection using the proposed constant alarm rate (CFAR) detector is performed on the RADARSAT-2 PolSAR data. Experimental results demonstrate the great efficiency of the P_G distribution and the corresponding parameter estimation method in data fitting of areas with different degree of homogeneity. Moreover, the successive CFAR detector can successfully complete the automatic target detection with low false alarm rate and high detection rate in complex clutter environment where the homogeneity of terrain varies sharply. [C8]

"Implementation of Adaptive FIR Filter for Pulse Doppler Radar"

Digital Signal Processing (DSP) systems involve a wide spectrum of DSP algorithms and their realizations are often accelerated by use of novel VLSI design techniques. Now-a-days various DSP systems are implemented on a variety of programmable signal processors or on application specific VLSI chips. This paper presents the design of Adaptive Finite Impulse Response (FIR) filter for moving target detection in various clutter conditions in Radar Receiver. The design uses pipelined COordinate Rotation DIgital Computer (CORDIC) unit and pipelined multiplier to get high system throughput and reduced latency in each of the pipelined stage. Saving area on silicon substrate is essential to the design of any pipelined CORDIC. The area reduction in proposed design can be achieved through optimization in the number of micro rotations. For better adaptation and performance of Adaptive Filters and to minimize quantization error, the numbers of iterations are also optimized. [C9]

"Heart-beat detection and ranging through a wall using ultra wide band radar"

Heart-beat detection has found many applications in military and bio-medical areas. Many of these applications focus on the use of impulse based ultra wide band (UWB) radars. This in-turn requires expensive hardware and consumes more power (for a given range) compared to stepped frequency continuous wave (SFCW) radars. However, the micro-Doppler characteristic of human body can be detected by SFCW radar at much lower sampling rates and power. It can help in distinguishing a living and a non-living target. In addition, SFCW radar can help separate Doppler signatures in down-range, thus enabling it to look for multiple human targets. UWB radars operate at a bandwidth higher than 0.5 GHz and have the benefit of high range resolution. This paper focuses on the experimentation of a technique to obtain the range and Doppler of a human body using UWB-SFCW radar and moving target indicator (MTI) filter, in the presence of an interfering wall. [C10]

"Angle-Doppler Estimation in Heavy Correlated Interference"

In this paper, a Prony estimation method on wavelet-transformed space-time signal is proposed with Adaptive Simulated Annealing (ASA) algorithm as a global optimizer. In addition to denoising property of wavelet transformation, the proposed approach appeals to its decor relating nature. Our method improves the

performance of radar systems with large array antenna, such as OTH radars in STAP applications. We show that the conglomeration of Prony estimator and ASA algorithm achieve good performance in terms of detection and resolution in comparison with the classical STAP algorithm in the presence of powerful external correlated interference. Moreover, we present how to apply STAP technique to parameter estimation of target in the correlated non-Gaussian interference environments that causes Maximum Likelihood (ML) function be nonlinear with respect to the angle and Doppler. In the following, ASA algorithm is employed for global optimization of all nonlinear functions. Extensive simulations demonstrate that our proposed algorithm outperforms that previously reported estimators with extremely low computational cost. [C11]

"UWB microwave imaging system with a novel calibration approach for breast cancer detection"

A microwave imaging system prototype has been developed for early breast cancer detection. The system is based on impulse Ultra-Wideband (UWB) radar technology. A novel, practical calibration method has been applied in our system to remove the large received signals due to both skin backscattering and Tx/Rx antenna coupling, and to underline the reflection/scattering from object of interest. This calibration method is crucial to identify the malignant tissues in a low-contrast condition that the difference of dielectric properties between malignant tissues and healthy tissues is not more than 10%. The system has been used to detect the cylindrical targets from a breast model. With this novel calibration approach, our system has successfully detected and localized the targets with a diameter of 5mm in a low-contrast condition. Details of the experimental setup and experimental imaging results will be discussed in this paper. [C12]

"Novel Space-Time Processing Method for Airborne SAR to Detect and Image the Slowly Moving Targets"

In the paper the problem of the ground clutter rejection for airborne SAR is discussed. The features of space-time clutter filtering and clutter spectrum of airborne SAR imaging are analysed. It is pointed out that there exist some problems such as Doppler ambiguity and blind speed band expansion when STAP filtering is applied to the ground clutter cancellation. Aiming at the solving of difficulties in detecting and imaging the slowly moving target with single-channel airborne SAR, a new method suitable for multi-channel airborne SAR to detect and image the slowly moving target is proposed, which can effectively avoid the blind speed and Doppler ambiguity and keep the processed data rate lower. Computer simulation results show that this method is valid. Compared with other method for detecting and imaging the slowly moving targets, the improvement factor obtained by the proposed method is narrower than that. [C13]

"The application of chaotic signal in MIMO radar"

Multiple Input Multiple Output (MIMO) radar is a new radar technique. It has many advantages over conventional phased radar in many ways such as anti-intercept of radar signal, low velocity target detection, and resolution. The signal design is a chief problem for radar. In this paper, we analyze the chaotic signal for MIMO radar. [C14]

"Fast Hough transform algorithm for radar detection"

In this paper, a fast algorithm for radar detection based on line Hough transform is presented. Unlike the traditional method, the idea of our proposed is that the point of data space should be mapped into the Hough parameter space of slope and intercept, where the relative position of the points in the data space is preserved. Then, only one time transformation of coordinate is employed to get the position of a batch points in parameter space. Therefore, the computation burden is significantly reduced. In addition, the detector performance is investigated. Finally, we illuminate the reduction of computation in details. [C15]

"Road extraction and its application in moving target detecion in SAR images"

This paper discusses a moving target detection method based on road extraction in SAR images. Firstly road pixels are initially extracted by fuzzy C mean (FCM) clustering. Then the image is divided into sub-block and the Hough transform is used to extract the segment candidates in each block. Combining the proximity, the con-linearity and the membership of the segment candidates, the reasonable roads are preserved and false roads are removed. Integration of a priori information on road traffic network, making use of binary statistical hypothesis testing and change detection method, moving target detection performance in SAR images is improved. Simulation results demonstrate the effectiveness of the method. [C16]

"Low-power low-complexity carrier-based UWB transmitter in 90nm CMOS for wireless biomedical radar sensing applications"

This paper presents a low-power low-complexity ultra-wide band (UWB) transmitter designed in 90nm CMOS

technology for UWB radar sensing applications. The proposed design is carrier-based and is targeting for motion detection, biomedical imaging, and short range data communications. This non-coherent UWB transmitter, generates on-off modulated signals at different carrier frequency within the 3-10 GHz band. A voltage controlled oscillator generates a modulated pulse consisting of multiple cycles of sinusoidal waves with smaller bandwidth. The carrier frequency can be adjusted over the whole UWB frequency band by changing the capacitance of a capacitor bank. The transmitter driver controls the output power and matches the 50Ω antenna load. The average power consumption of the transmitter is 1.85mW at a carrier frequency of 9GHz using 1V supply. [C17]

"Adaptive Threshold for Fast Signal Detection in Multi-target Tracking"

An adaptive threshold algorithm is used for frequency-shift keying (FSK) demodulation in multi-targets and radar communication system. The special algorithm is needed because of the radar burst signal in this system. The selection of the threshold is generally a tradeoff between the goals of maximizing the probability of detection while minimizing false alarm. It replies radar pulse immediately without carrier synchronization, so the threshold is calculated by the priori knowledge of the signal amplitudes. CIC filter can save resource and is used after first down-conversion, but its performance of detection is not as good as FIR filter. Simulation results show that the adaptive threshold algorithm can reduce the probabilities of miss detection and false alarm. [C18]

"Fast response Retrodirective Radar"

This paper shows the ability of an all analogue Retrodirective Radar, the first of its type, to provide continuous surveillance and near instantaneous target acquisition while automatically beam steering in real time onto a target which is presented to it. Assessment of the phase conjugation unit shows that the Radar is capable of operating either in CW or in pulsed mode. Test results are presented which show that Retrodirective tracking of targets travelling at speeds in excess of 780 m/s is possible. To confirm tracking ability bistatic results of a small near field target are presented, and the capability is also shown to extract the position of the near field target with only very simple calculations, with no DSP circuitry required. [C19]

"Oblique projection polarization filtering and its performance in High Frequency Surface Wave Radar"

A novel polarization filtering method based on the oblique projection operator is proposed to improve the target detection performance for High Frequency Surface Wave Radar (HFSWR) system in this paper. The performance of the proposed oblique projection polarization filter (OPPF) is detailedly analyzed in presence of additive Gaussian white noise and the desired signal's Mean Square Error (MSE) with the estimation error of the interference polarization parameter is discussed in detail. Numerical simulation results show that the proposed OPPF can enhance the target while mitigate the interference perfectly. [C20]

"Track-before-detect algorithm based on dynamic programming for multi-target tracking"

A new dynamic programming based track before detect (DP-TBD) algorithm is presented to detect and track multi-target when SNR is low and target number is unknown. The technique combines the possible target state estimation using PDA with standard DP-TBD algorithm. And with the assumption that one measurement can originate from one target or clutter, the track separation phenomenon can be minimized and the target number can be obtained. Since the like-ratio function is not included in the merit function, the new method can be used without the priori information of the noise. Simulation results reveal that the new DP-TBD method has good performance when detecting target number and recovering target trajectories. [C21]

"FM interference suppression for PRC-CW radar based on STFT and median filtering"

The influence of FM interference on correlation detection performance of the pseudo random code continuous wave (PRC-CW) radar is analyzed. It is found that the correlation output deteriorates greatly when the FM interference power exceeds the anti-jamming limitation of the radar. According to the fact that the PRC-CW radar return signal is a wideband pseudo random signal occupying the whole TF plane, whereas the FM interference signal is well concentrated in the TF plane, a new method is proposed based on STFT and median filtering for FM interference suppression. This method implements the filtering of the received signal by substituting the median filter output for only a portion of the TF plane corrupted by the interference. The echo signals corrupted by two types of interferences including linear FM (LFM) and sinusoidal FM (SFM) forms under different signal-to-jamming ratio (SJR) situations are simulated. It is shown that the method can effectively suppress the FM interference and improve the performance of target detection significantly. [C22]

"Tracking evasive objects via a search allocation game"

This paper outlines a strategy for tracking evasive objects in discrete space using game theory to allocate sensor resources. One or more searchers have to allocate the effort among the discrete cells to maximize the object detection probability within a finite time horizon or minimize the expected search time to achieve the desired detection probability under a false alarm constraint. We review the standard formulations under a sequential decision setting for finding stationary objects. Then we consider both robust and optimal search strategies and extend the standard search problem to a two-person zero-sum search allocation game where the object wants to hide from the searcher and the object has incomplete information about the searcher's remaining search time. We discuss how the results affect the sensor management and mission planning for cooperative unmanned aerial vehicle (UAV) search tasks and provide simulation examples to show the effectiveness of the proposed method compared with random search strategy. [C23]

"Status and trends in AESA-based radar"

Radar technology, predominantly in the area of defence applications, is in a continuous process of extending its present capabilities. Especially Active Electronically Scanned Array (AESA) radars, with their unprecedented degree of operational flexibility, are currently about to revolutionise the performance of air- and spaceborne, naval and ground radars. The current status of AESA radar and the trends in system and technology advances are discussed. Trends on system level will be the use of MIMO-architectures and shared antenna apertures. [C24]

"Detection of human targets using ultra-wide band through-the-wall radar"

In this paper, an ultra-wide band (UWB) through-the-wall radar (TWR) prototype is described, and experiments are performed on detecting human targets behind wall. An adaptive background subtraction method is applied to signal processing to reduce clutter and antenna couplings. Range-time histories of an adult male person behind wall are presented for different locomotion states such as standing, marking time, and walking along cross-range direction. [C25]

"Radar target detection and Doppler ambiguity resolution"

A Continuous Wave (CW) radar with a linear Frequency Modulation (FM) and a very short chirp duration is considered in this paper. A single target range and Doppler frequency measurement consits of a sequence of L chirp signals with the same chirp duration. The maximum unambiguously measurable radial velocity in this case is limited by a minimum chirp duration. Therefore fast moving targets will cause ambiguous measurement results, that have to be resolved. The technique of resolving ambiguities on the basis of several subsequent measurements with different ambiguity interval lengths is well known as Chinese Remainder Theorem (CRT). It has been extensively described in literature [2]. Two different signal processing approaches to apply this technique for the resolution of ambiguities are compared in this paper. These do not differ in terms of the ambiguity resolution itself, because they are based on the same principle. The detection performance however is different. [C26]

"Adaptive hough detector threshold analysis in presence of randomly arriving impulse interference"

In this paper a technique of Hough detector threshold procedure for moving target detection in conditions of randomly arriving impulse interference with Poisson distributed flow and Raleigh amplitude distribution is proposed. The expressions of detection and false alarm probability are derived for a highly fluctuating Swerling II target. A comparative analysis of the performance of a Hough detector with fixed threshold and other five Hough detection structures keeping constant false alarm rates is done. These are CA CFAR (Cell Averaging Constant False Alarm Rate), EXC CFAR (Excision Constant False Alarm Rate), CFAR BI (Constant False Alarm Rate with Binary Integration), EXC CFAR BI (Excision Constant False Alarm Rate with Binary Integration) and API CFAR (Adaptive censoring Post detection Integration Constant False Alarm Rate). A method for losses estimation, which allows choosing of optimal detector parameters, is developed. Obtained are estimates of the effectiveness of Hough detector in presence of randomly arriving impulse interference and they are compared to patterns researched from other authors. The achieved results can be successfully applied for radar target detection and in the existing communication network receivers that use pulse signals. [C27]

"A software defined UMTS passive radar demonstrator"

Passive radar systems, also referred to as Passive Coherent Location systems (PCL), exploit non-cooperative illuminators of opportunity (IO) in order to detect and track targets. Some of the main advantages of such systems with respect to conventional radars include low cost architectures, low energy requirements, the capability of operating without any spectrum resource allocation and a potentially null probability of intercept. In this paper, we introduce a passive radar demonstrator based on the use of UMTS (Universal Mobile

Telecommunications System) signals as a source of opportunity. An overview of the UMTS standard and some preliminary measurements are firstly presented in order to verify the suitability of the UMTS waveform for radar applications. Secondly, a low cost software defined experimental radar system is introduced together with a measurement scenario. Finally, some live data detection results are presented and discussed in order to demonstrate the capability of this passive radar system. [C28]

"Signal reconstruction as an effective means of detecting targets in a DAB-based PBR"

This paper aims to validate the method of target detection by correlating a surveillance (target) signal with a reconstructed reference signal in DAB-based Passive Bistatic Radar (PBR). Whereas most conventional PBRs condition the surveillance signal by suppressing Direct Signal Interference (DSI) and then correlate this with a similarly measured reference signal to reveal targets, the approach adopted at FHR is to correlate the surveillance signal with a perfectly reconstructed, error-free, copy to the transmitted signal. [C29]

"Robust detection in continuous-wave noise radar-experimental results"

In the paper the problem of target detection in continuous-wave noise radar in the presence of impulsive external noise is addressed. If received noise has distribution different than Gaussian, the classical correlation receiver does not provide the optimal results and the performance of the radar is seriously degraded. In order to restore the sensitivity lost due to the impulsive noise a robustification method is proposed. In the method a nonlinear function is applied to the signal in order to remove the outliers. The method is verified on real-life signals. [C30]

"Tracking of dismounts moving in cross-range using GMTI radar"

The detection of dismounts has a variety of applications, such as tracking remotely for battlefield awareness or at check-points. In this paper we describe the sensitivity of ground moving target indication (GMTI) radar as a dismount moves in cross-range, where the radial velocity is difficult to detect but the micro-Doppler of moving dismounts makes feasible. GMTI target detections are used as a subject moves perpendicular to the beam of the radar. These measurements are compared to vehicular and animal measurements which have minimal micro-Doppler and are much more difficult to detect in their cross-range motion. Ground truth is gathered using video to validate the radar data. We find a detection probability on dismounts in excess of 85% with a low false positive rate of 2%. [C31]

"Cargo ship RCS estimation based on HF radar measurements"

High-Frequency (HF) radars are operated in the 3-30 MHz frequency band. For oceanographic applications low transmit power HF radar systems have been developed, which use surface electromagnetic wave propagation along the salty ocean surface. The WERA HF radar system transmits a power of 30 Watts but achieves detection ranges up to 200 km. Hence the radar system can be used for many applications in coastal monitoring. The measured radar data were analyzed together with simultaneously available Automatic Identification System (AIS) information, which shows current ship position, speed, course and type. This paper presents the target reflectivity measurements as signal-to-noise ratio (SNR) to estimate the radar cross section (RCS) of cargo ships. [C32]

"Moving target estimation using distributed MIMO radar in non-homogeneous clutter"

In this paper, we consider parameter estimation for moving target detection using a distributed MIMO radar, where the multi-static transmit-receive configuration causes non-homogeneous clutter. Specifically, the clutter power for the same resolution cell may vary significantly from one transmit-receive pair to another, due to azimuth-selective backscattering. Moreover, the clutter power may also vary across resolution cells in the neighborhood of the test cell. In this work, the non-homogeneous clutter is modeled using a subspace approach, whereby the subspace is spanned by a few Fourier bases and the non-homogeneity of the clutter is captured by coefficients that vary with different transmit-receive pairs and/or different resolution cells. The choice of the Fourier bases is based the fact that the clutter Doppler spectrum is bandlimited. We develop a maximum likelihood (ML) estimator for the parameters associated with the target and clutter. The Cramer'r-Rao bound (CRB) for velocity estimation is also derived. Numerical results show that the proposed estimator outperforms an alternative solution that ignores the non-homogeneous nature of the clutter. [C33]

"Fast automatic target detection of large scene SAR image based on parallel computing"

An automatic target detection algorithm of SAR image based on parallel computing is presented in this paper. The experimental results based on constant false alarm rate detector verify that the algorithm adapts well to the

parallel processing system with high performance and parallel efficiency. That means the algorithm has high real time property. [C34]

"Scheduling of tasks with fuzzy dwell times in a multifunction radar"

This paper proposes an algorithm for scheduling tasks in a multifunction radar. A greedy algorithm designed for tasks with crisp dwell times is extended to situations where the dwell time is allowed to be fuzzy. The greedy scheduling algorithm attempts to schedule as many tasks as possible while maintaining temporal regularity between the task update intervals. Tasks that cannot be scheduled by the greedy algorithm are then input to the fuzzy scheduling algorithm, which adjusts the dwell time of the tasks according to their membership function until they can be scheduled. An example scheduling scenario is provided to demonstrate the behavior of the proposed algorithm. [C35]

"A probabilistic framework for joint segmentation and tracking"

Most tracking algorithms implicitly apply a coarse segmentation of each target object using a simple mask such as a rectangle or an ellipse. Although convenient, such coarse segmentation results in several problems in tracking-drift, switching of targets, poor target localization, to name a few-since it inherently includes extra non-target pixels if the mask is larger than the target or excludes some portion of target pixels if the mask is smaller than the target. In this paper, we propose a novel probabilistic framework for jointly solving segmentation and tracking. Starting from a joint Gaussian distribution over all the pixels, candidate target locations are evaluated by first computing a pixel-level segmentation and then explicitly including this segmentation in the probability model. The segmentation is also used to incrementally update the probability model based on a modified probabilistic principal component analysis (PPCA). Our experimental results show that the proposed method of explicitly considering pixel-level segmentation as a part of solving the tracking problem significantly improves the robustness and performance of tracking compared to other state-of-the-art trackers, particularly for tracking multiple overlapping targets. [C36]

"Target detection in Doppler radar with PSK signals"

The aim of this article is to test the effectiveness of the known structures of radar signal processing (RSP) that employ CFAR processors in order to detect moving targets in the frequency domain, depending on the chosen width of velocity channels (the number of FFT). The Doppler radar is radar with continuous transmission of PSP (Phase Shift Keying) signals. Real records that have been produced by Doppler radar for the case of moving people or cars on the background of trees are used in the study. The results obtained lead to believe that detection of targets with CA CFAR processors provides the required effectiveness in case when the velocity channel width is correctly defined. [C37]

"Exploiting polarimetric diversity to mitigate the effect of interferences in FM-based passive radar"

In this paper the effect of interfering sources is characterized on the performance of a passive bistatic radar exploiting a FM radio broadcast transmitter. The signals emitted on same/adjacent frequency channels by other potential transmitters located in the surveillance area are shown to significantly affect the performance of the considered system in terms of both disturbance cancellation and target detection capability. To mitigate the effect of such interferences, the exploitation of different polarizations is considered for the surveillance antenna. A preliminary approach is proposed to jointly exploit the diversity of information conveyed by different polarizations. The results are shown against a real data set collected by an experimental multi-channel passive radar prototype developed and fielded at the Infocom Dept. of the University of Rome "La Sapienza" (Italy). [C38]

"Multiband experimental PCL system: Concept and measurement results"

Over recent years, interest in passive radar systems using non-cooperative analogue and digital broadcast transmitters as illuminators has been growing significantly. They are being considered as possible future stand-alone systems or as gap fillers for existing air surveillance systems [1]. Recently passive radar is also discussed for the deployment in border surveillance as well as for detection of land and sea targets. The technical maturity and detection performance of experimental and prototype system implementations has been steadily improving. Starting from early FM-broadcast-based systems, the evolution to DAB-based and DVB-T-based digital systems is currently ongoing. In this paper, a multiband experimental passive radar system exploiting FM, DAB and DVB-T transmitters is presented. The hybrid system concept is described and the results of various measurements with different types of aerial and sea targets are shown. [C39]

"Facial expression invariant head pose normalization using Gaussian Process Regression"

We present a regression-based scheme for facial-expression-invariant head pose normalization. We address the problem by mapping the locations of 2D facial points (e.g. mouth corners) from non-frontal poses to the frontal pose. This is done in two steps. First, we propose a head pose estimator that maps the input 2D facial point locations into a head-pose space defined by a low dimensional manifold attained by means of multi-class LDA. Then, to learn the mappings between a discrete set of non-frontal head poses and the frontal pose, we propose using a Gaussian Process Regression (GPR) model for each pair of target poses (i.e. a non-frontal and the frontal pose). During testing, the head pose estimator is used to activate the most relevant GPR model which is later applied to project the locations of 2D facial landmarks from an arbitrary pose (that does not have to be one of the training poses) to the frontal pose. In our experiments we show that the proposed scheme (i) performs accurately for continuous head pose in the range from 0° to 45° pan rotation and from 0° to 30° tilt rotation despite the fact that the training was conducted only on a set of discrete poses, (ii) handles successfully both expressive and expressionless faces (even in cases when some of the expression categories were missing in certain poses during the training), and (iii) outperforms both 3D Point Distribution Model (3D-PDM) and Linear Regression (LR) model that are used as baseline methods for pose normalization. The proposed method is experimentally evaluated on data from the BU-3DFE facial expression database. [C40]

"Ocean-land segmentation based on active contour model for SAR imagery"

Ocean-land segmentation is a basis for oceanic targets detection for SAR imagery. The traditional manual segmentation method can acquire a fairly good result, while it is unable to achieve a satisfying efficiency. Thus the manual method is unsuitable for batch processing. Ocean map based land masking method requires a priori information, which restricts its application. This paper presents an automatic active contour model based ocean-land segmentation method for SAR imagery. This method forces the active contour to the real coastline by variation level set. Under the restriction of minimizing a given energy function, the method obtains the final segmentation result when the active contour is overlapped on the coastline. In addition, an optimizing method is proposed to improve its computation efficiency, which makes our segmentation method more applicable. [C41]

"The new generation of European E-scan fighter radars"

Two European programmes towards an airborne E-scan radar have obtained major attention: AMSAR, a generic demonstrator for developing the technology required for an AESA radar and for proving its operational capabilities, and CAESAR that paves the way to the next generation of radar for Eurofighter. Future sub-array AESA architectures and multi-channel receivers will enable efficient jammer suppression by use of Adaptive Beam Forming. The technology basis of T/R-Modules will move to Gallium- Nitride, promising improvements in efficiency, output power and miniaturisation. [C42]

"Multiple-frequency interferometric velocity SAR location and imaging of elevated moving target"

Locations of moving targets in synthetic aperture radar (SAR) images are determined not only by their geometric locations but also by their velocities that cause their SAR images defocused, smeared, and mis-located. With a linear antenna array, velocity synthetic aperture radar (VSAR) can detect, focus, and locate slowly moving targets well. However, it may mis-locate fast moving targets in the azimuth (cross-range) direction, and sometimes even in the ground range direction if the targets are elevated above the ground. In this paper, we propose an antenna array approach with cross-track interferometry, in which multiple wavelength signals are transmitted. It is shown that our proposed multiple-frequency interferometric velocity SAR (MFIn-VSAR) can locate both slowly and fast moving elevated targets correctly. [C43]

"Distributed target detection in Through-the-Wall Radar Imaging using the bootstrap"

The problem of distributed detection and decision fusion in Through-the-Wall Radar Imaging (TWRI) is considered. We deal with the multi-viewing case in which images corresponding to different radar locations can be collected. We present a method to adapt conventional distributed detection schemes to the scenario when no a priori knowledge about image statistics from any view is available. Further, a new scheme for estimating quality information of local detectors in a distributed detection scenario is proposed. We apply bootstrap techniques to draw inference from the radar measurements of the behind the wall scene. Simulation results as well as experimental data are used to demonstrate the performance of the proposed approach. [C44]

"Feature extraction in Through-the-Wall radar imaging"

This paper deals with the problem of automatic target classification or Through-the-Wall radar imaging. The proposed scheme considers stationary objects in enclosed structures and works on the SAR image rather than the raw data. It comprises segmentation, feature extraction based on superquadrics, and classification. We present a recursive splitting tree to obtain optimum parameters for feature extraction. Support vector machines

and nearest neighbor classifiers are then applied to successfully classify among different indoor targets. The classification methods are tested and evaluated using real data generated from synthetic aperture Through-the-Wall radar imaging experiments. [C45]

"Target detection in MIMO radar in the presence of Doppler using complementary sequences"

In this paper, we present a method for detecting a point target using multiple antennas when the relative motion between the receivers and the target induces a non-negligible Doppler shift. As a key illustrative example, we consider a 4Ч4 system employing a unitary matrix waveform set, e.g., formed from Golay complementary sequences. When a non-negligible Doppler shift is induced by the target motion, the wave-form matrix formed from the complementary sequences is no longer unitary, resulting in significantly degraded target range estimates. To solve this problem, we adopt a subspace based approach exploiting the observation that the receive matrix formed from matched filtering of the reflected waveforms has a (non-trivial) null-space. Through processing of the waveforms with the appropriate vector from the null-space, we can significantly improve the detection performance. We provide simulation results to confirm the theoretical analysis. [C46]

"MIMO radar detection under phase synchronization errors"

We consider the problem of target detection for coherent multi-input multi-output (MIMO) radar with widely separated antennas in the presence of phase synchronization mismatch between the transmitter and receiver pairs. First, we introduce a data model using von-Mises distribution to represent the phase error terms. Then we employ expectation-maximization algorithm to estimate the error distribution parameter and target returns as well as the noise variance. We develop a generalized likelihood ratio test (GLRT) target detector using these estimates and demonstrate the effect of phase uncertainties on the detection performance using Monte Carlo simulations. [C47]

"Fixed-point based autoregressive parameter estimation for space time adaptive processing"

Space time adaptive processing (STAP) is useful in radar processing to detect a target by filtering the clutter and the additive thermal noise. A derived version based on a multichannel autoregressive (M-AR) model of the clutter has the advantage of reducing the computational cost. Nevertheless, the estimation of the AR matrix parameters is a key issue because the clutter is not Gaussian in real cases. When dealing with an off-line solution, the multichannel least squares method (MLS) can be considered, but the estimation of the disturbance covariance matrix is required. In this paper, we suggest using the so-called fixed point method since it has "matrix- and texture-constant false alarm rate" property (matrix-CFAR and texture-CFAR) and it provides an unbiased and consistent estimate in a non-Gaussian case. A comparative study is then carried out between off-line M-AR based STAP methods and it points out the relevance of the solution we propose. [C48]

"Radar-based human detection via orthogonal matching pursuit"

Many current radar-based human detection systems employ some type of Doppler or Fourier-based processing, followed by spectrogram and gait analysis to classify detected targets. However, Fourier-based techniques inherently assume a linear variation in target phase over the aperture, whereas human targets have a highly nonlinear phase history. This mismatch leads to significant loss in SNR and integration gain. In this paper, an Enhanced Optimized Non-Linear Phase (EnONLP) detector is proposed that employs a dictionary to store possible target returns generated from the human model for each combination of parameter values. An orthogonal matching pursuit algorithm is used to compute a sparse approximation to the radar return that is optimal in the least squares sense. Performance of the EnONLP algorithm is compared to that of a parameter-estimation based algorithm and conventional, fully-adaptive STAP. [C49]

"New generation of radar systems enabled with cognition"

The analogy between the visual brain and radar has fueled Professor Simon Haykin's interest in studying the human brain for the past 25 years. He will address the formulation of the perceptionaction cycle that embodies five basic properties: Perception, Memory, Attention, Intelligence, and Language. Realizing that the language in radar information processing is different from that in the brain, it is natural to demand the first four properties of human cognition for a radar system to be cognitive. To satisfy this requirement, a hierarchical cognitive radar will be described that exploits local and global feedback loops around the receiver and transmitter, which are supplied with three distinct memory units: perceptual memory, executive memory, and action-perception matching memory. In so doing, the whole system is coordinated with its environment in a powerful way. Through the use of clever learning procedures, a hierarchical perception-action cycle is built. The stage is now set to present experimental results, which demonstrate how the tracking resolution capability of a radar system is progressively improved as the memory units in the system are added, one by one. Future research challenges

include: • Improvements to the cubature Kalman filter in the receiver for perception of the environment. • Approximate dynamic programming in the transmitter for action to control the environment. • Bayesian target detection. • Multiple target surveillance. • Cognitive phased array radar, providing the ultimate in performance. [C50]

"A track-before-detect algorithm for statistical MIMO radar multitarget detection"

This paper investigates the early detection problem of multiple moving targets in statistical MIMO radar systems using the track-before-detect (TBD) techniques. At first, assuming prior knowledge of the number of targets, a binary generalized likelihood ratio test (GLRT) is derived, which shows that the optimal implementation of the GLRT requires multidimensional joint search. To reduce the implementation complexity, a suboptimum multitarget TBD algorithm using successive-target-cancellation and polar Hough transform (STC-PHT) is proposed. In addition to low complexity, the new proposed algorithm doesn't need the prior information of the number of targets, and can avoid the implementation of multi-hypothesis test when the number of targets is unknown. The simulation results show that this algorithm can effectively improve the detection performance of statistical MIMO radar at low signal-to-noise ratio (SNR). [C51]

"Automatic through the wall detection of moving targets using low-frequency ultra-wideband radar"

This paper presents a time-domain, Moving Target Indication (MTI) processing formulation for detecting slow-moving personnel behind walls. The proposed time-domain MTI processing formulation consists of change detection and automatic target recognition algorithms. We demonstrate the effectiveness of the MTI processing formulation using data collected by an impulse-based, low-frequency, ultra-wideband radar. In this paper, we describe our radar system and algorithms used for the automatic detection of moving personnel. We also analyze the false alarm and detection rate of four operational scenarios of personnel walking inside wood and cinderblock buildings. [C52]

"Step-frequency radar with compressive sampling (SFR-CS)"

This paper proposes a novel radar system, namely step-frequency with compressive sampling (SFR-CS), that achieves high target range and speed resolution using significantly smaller bandwidth than traditional step-frequency radar. This bandwidth reduction is accomplished by employing compressive sampling ideas and exploiting the sparseness of targets in the range-speed space. [C53]

"Single antenna time reversal detection of moving target"

This paper is concerned with a moving target detection using time reversal in dense multipath environments. We show that the Doppler shift in the time reversal re-transmission simplifies the detector design, yet still achieves the focusing effect. Thus, the Doppler diversity is utilized to achieve high target detectability by time reversal. [C54]

"Multipath exploitationwith adaptivewaveform design for tracking in urban terrain"

We integrate multipath exploitation with adaptive waveform design in order to increase the tracking performance of a vehicle moving in urban terrain. Mitigation of both clutter and strong multipath returns can result in increased target detection. However, exploiting multiple bounces from obstacles such as buildings can be shown to increase radar coverage and scene visibility, especially in the absence of direct line-of-sight paths. For this purpose, we formulate the multipath propagation of an arbitrary number of specular bounces in urban terrain for three-dimensional motion. We then further exploit and optimize multipath returns by dynamically selecting the parameters of the transmitted waveform to minimize the predicted mean-squared tracking error. We demonstrate our proposed approach in a realistic urban environment by varying the type of measurement to include regions of obscuration and different number of multipath bounces. [C55]

"A ternary pulse compression code: Design and application to radar system"

In this paper, we present new developed ternary code-punctured binary sequence-pair, give its definitions and the autocorrelation properties. We also investigate Doppler shift performance of the proposed code. The significant advantages of this ternary codes over conventional pulse compression codes, such as the widely used Barker codes, are zero autocorrelation sidelobes and the longer length of the code which can be as long as 31 so far. We apply our new ternary codes to radar system for target detection and observe that our codes outperform some other conventional pulse compression codes. [C56]

"Slow-time multi-frequency radar for target detection in multipath scenarios"

We propose a method to detect a target in the presence of multipath reflections, employing sequential transmission of multiple frequencies in a slow-time (pulse-to-pulse) approach. First, we develop a parametric measurement model that accounts for the multipath components at multiple frequencies as well as Doppler shifts. Then, we develop a statistical detection test and analytically evaluate its performance characteristics. Based on the performance analysis, we propose an adaptive algorithm to select the best combination from a subset of frequencies that maximizes the detection performance. Our numerical examples show that the sequential approach requires more coherent pulses to match the performance of the simultaneous usage of multiple carriers in OFDM format. We also study the extent of performance degradation due to employing a subset of available frequencies. [C57]

"New detection algorithm for weak target signal embedded in direct path interference using Signal Phase Matching Principle"

A detection method for weak signals embedded in direct-path interference is discussed. This method is based on FM radio signals as the illuminator of passive radar. On the basic of Signal Phase Matching Principle, a new algorithm for suppressing the direct-path interference is proposed in wave-beam domain. To improve the declining performances of the algorithm when the amplitude fluctuates, a compensatory factor is presented. The simulation results show the validity of the algorithm and the compensatory method. [C58]

"Extend Kalman Gaussian mixture probability hypothesis density filter based on radar and IR sensor fusion"

In this paper, we proposed a method to fuse data from radar and IR sensor in Extend Kalman probability hypothesis density (EK-GMPHD) filter. Firstly the multi-target is estimated with infrared (IR) sensor using EK-GMPHD filter, and then the filtering results are fused with measurements from radar through sequential filter, in this way, the multi-target state is updated at the tracking system. Under false alarms, missed detections and dense targets environment, this method has a high reliability when tracking multi-target. Simulation experiments are presented to demonstrate the performance of the proposed method. [C59]

"Human detection and tracking via Ultra-Wideband (UWB) radar"

This paper presents an algorithm for human presence detection and tracking using an Ultra-Wideband (UWB) impulse-based mono-static radar. UWB radar can complement other human tracking technologies, as it works well in poor visibility conditions. UWB electromagnetic wave scattering from moving humans forms a complex returned signal structure which can be approximated to a specular multi-path scattering model (SMPM). The key technical challenge is to simultaneously track multiple humans (and non-humans) using the complex scattered waveform observations. We develop a multiple-hypothesis tracking (MHT) framework that solves the complicated data association and tracking problem for an SMPM of moving objects/targets. Human presence detection utilizes SMPM signal features, which are tested in a classical likelihood ratio (LR) detector framework. The process of human detection and tracking is a combination of the MHT method and the LR human detector. We present experimental results in which a mono-static UWB radar tracks human and non-human targets, and detects human presence by discerning human from moving non-human objects. [C60]

"Robust waveform design for MIMO radars"

The problem of robust waveform design for multiple-input, multiple-output radars equipped with widely-spaced antennas is addressed here. Robust design is needed as a number of parameters are unknown, e.g., the target scattering covariance matrix and, possibly, the clutter covariance matrix. A min-max approach is proposed, so that the code matrix is designed to minimize the worst-case cost (or equivalently maximize the corresponding figure of merit) under all possible target (or target and clutter) covariance matrices. Surprisingly, the same min-max solution applies to many commonly adopted performance measures, such as the average signal-to-clutter-plus-noise ratio, the mutual information between the received signal echoes and the unknown target response, and the approximation of the detection probability in the high- and low-signal regimes. [C61]

"Fast response Retrodirective Radar"

This paper shows the ability of an all analogue Retrodirective Radar, the first of its type, to provide continuous surveillance and near instantaneous target acquisition while automatically beam steering in real time onto a target which is presented to it. Assessment of the phase conjugation unit shows that the Radar is capable of operating either in CW or in pulsed mode. Test results are presented which show that Retrodirective tracking of targets travelling at speeds in excess of 780 m/s is possible. To confirm tracking ability bistatic results of a small

near field target are presented, and the capability is also shown to extract the position of the near field target with only very simple calculations, with no DSP circuitry required. [C62]

"Interferometric detection of the angular velocity of moving objects"

This paper presents a new method of detecting the angular velocity of moving objects using passive interferometry. The new technique is presented using a millimeter-wave correlation interferometer to measure the angular velocity of a moving target directly, without the need for multiple looks. As the object passes through the interferometer beam pattern the frequency of the signal output is dependent on the angular velocity of the object, and a simple time-frequency analysis visually displays the angular velocity of the target. The basic theory is presented and experimental results showing the detection of a walking person are presented. [C63]

"Novel image reconstruction algorithm for a UWB cylindrical Microwave Imaging System"

A theoretical and experimental study of a novel image reconstruction algorithm for an Ultra Wideband (UWB) Microwave Imaging System aiming at detecting and locating small targets in a homogenous circular cylindrical dielectric body is presented. The system uses a double circular scan in which the second scan is achieved after rotating by a small angle the antenna sub-system or the imaged body. The obtained two sets of data serve the purpose of subtracting the background that masks the target. Assuming that the target is asymmetric with respect to the axis of rotation, the difference data includes the original target and its negative "ghost". In order to eliminate the "ghost" only the positive valued difference data is extracted. This data is scaled and mapped to show the original target location. The validity of the proposed image reconstruction algorithm is demonstrated in an example of a cylindrical plastic container filled with a vegetable oil and small cylindrical targets. [C64]

"Theoretical Analysis on Range Accuracy of Laser Fuze"

Ranging accuracy is one of the important parameters which are used to evaluate performance of laser fuze. It's actually measure the flight time of laser when the laser fuze measuring the range of target. The pulse system carries on the time measuring directly, but the continuous wave system obtains the flight time indirectly through the difference frequency from the echo wave mixed local oscillation. Threshold method is often adopted to detect echo signal of pulse-gated laser fuze, but if the waveform of detected laser signal distorts or fluctuates with extraneous disturbances, using threshold method often leads to large measurement error and low accuracy. Through analysis the interior and external cause of ranging error on the linear frequency modulation continuous wave(LFMCW) laser fuze, the ranging error which caused by interior noise is less than 5cm when the false alarm probability is 10-4 and the probability of detection is 99.99%. The ranging error which caused by aerosol is less than 11cm when the visibility is under 40m. The total ranging error of laser fuze is less than 16cm. The simulation result shown that the ranging accuracy of LFMCW laser fuze satisfies the ranging request of pinpoint attack ammunition completely. [C65]

"Detection of weak moving targets based on 2-D range-Doppler FMCW radar Fourier processing"

This paper deals with a FMCW radar measurement scheme and a 2-D range-Doppler FMCW radar Fourier processing that is especially suited to detect very weak moving targets. A 2-D Fourier transform is applied to a larger set of consecutively measured FMCW radar beat signals. By this a phase coherent evaluation of a very long measuring time and a highly sensitive target separation in range and Doppler dimension is feasible. Applications of the proposed method are for example live sign detection of trapped or buried people, intruder detection or level measurements to organic fluids. The practical application of the described method is illustrated with a 24 GHz FMCW radar sensor system. The signal evaluation was implemented on a field programmable gate array (FPGA) to facilitate real time processing. Exemplary measurement results are presented to illustrate the capability of the applied method. [C66]

"Time allocation in cognitive radar for multitarget detection with dynamic programming"

The radar performs three main functions: search, tracing and weapon engagement. Each of functions occupies amount of time, energy and computation resource of the radar system. For cognitive radar, it should have the basic function which is learning. The radar needs to manage its resources dynamically and interactively between the setting of radar parameters to optimize the tasks to be carried out and perceive environment highlights the role in which knowledge and intelligence will be central in cognitive radar performance. The problem discussed here is the time allocation of cognitive radars in a multitarget environment. In this paper, we develop the optimization criterion based on the detection probabilities based on dynamic programming algorithm(DPA). [C67]

"The Research of Vision Calibration Method for Target Localization"

An important task for target localization is camera calibration, whose purpose is to estimate the internal and external parameters of cameras. A exact mathematical model was established based on a strict geometric constraint relationship. A fast method of external common tangent was provided to obtain the image coordinates. The other parameters of the camera was computed in a reasonable method to guarantee the parameter accuracy of the camera. After the position of the spot on the calibration template is computed based on camera calibration parameters, the computed spot position is compared with its real position for verifying its accuracy. The experiments indicate that the calibration parameters obtained by the method are accurate and reliable, the computing speed and the accuracy are effectively improved. The model is accuracy and stability, and the accuracy requirement for the position estimation of the target localization can be satisfied. [C68]

"Breast surface reconstruction algorithm for a multi-static radar-based breast imaging system"

The estimation of the skin reflection is a crucial step towards successful breast tumour detection. This paper investigates the two-dimensional improved version of an existing general purpose technique for estimating target objects of arbitrary shape. The ability of the proposed method in estimating the breast skin location is tested over a wide range of realistic FDTD-based scenarios with results demonstrating accurate estimation of the breast skin location. [C69]

"The Reverberating Chamber as emulator of radar ground clutter Doppler spectra"

The emulation of real scenarios is a topic of considerable interest in several radar applications especially for determining the performance of target detection against ground clutter. The development of new applications calls for emulators able to physically reproduce real scenarios. This paper introduces a new employment of the Reverberating Chamber (RC) as emulator of radar ground clutter Doppler spectra. Experiments accomplished at the Universita di Napoli Parthenope (formerly Istituto Universitario Navale, IUN) show how by properly modulating the velocity of stirrers used for measurements, real scenarios, such as windblown vegetation under several wind speed conditions, can be emulated in RC. [C70]

"Vital signs monitoring with a UWB radar based on a correlation receiver"

In the first part of this publication, vital signs detection observing small amplitude changes due to the movement of a target in front of the radar is shown. In the context of vital signs monitoring the target is the chest of human beings. This basic principle is also used in continuous wave (CW) radars, but the presented impulse-based UWB radar has moreover a range gating capability. Consequently, the target distance can be obtained and different targets (persons) can be monitored. Several measurement results using this measurement principle for respiration and in particular for heart beat monitoring are presented and discussed. Furthermore, the shortcomings of this method are depicted. In the second part, advanced signal post-processing by deconvolution with a Wiener filter is presented, leading to an improved resolution performance for the realized UWB radar system. Promising results of this method show that small targets can be identified in a multi-target scenario. Therefore, the movement of small targets, e. g. the heart muscle within the human body, could be tracked directly. [C71]

"Low velocity small radar target detection in maritime environment"

Researches on target detection are mainly focus on the amplitude characteristics nowadays. Sometimes the only use of amplitude characteristics is not enough to describe the signal, so that the target detection performance is usually poor. In this essay a method to make use of the information "hidden" in the signal phase is put forward, the theory is based on polynomial fitting of the signal phase train structure. At last, the method is validated using actual data. [C72]

"Low speed target detection with short CIT in HF surface wave radar"

High frequency surface wave radar can detect targets beyond the horizon. It needs long coherent integration time (CIT) to detect low speed targets, such as ships, in the environment with sea clutter. In order to improve the efficiency of the radar system, and avoid the Doppler broadening caused by long CIT, it is necessary to shorten coherent integration time. Modern spectrum estimation technique is adopted to extract Doppler information from HF radar echo signals. It can provide high resolution to realize ship detection in short CIT. The real data processing and analysis show that the autoregressive spectrum estimation technology is effective to detect low speed target in short CIT in high frequency surface wave radar. [C73]

"A novel single-channel SAR-GMTI method based on defocusing shifted difference"

A novel single channel SAR-GMTI method is proposed in this paper. When the azimuth mismatch filter performs

compression, it induces shifted difference between the stationary and moving targets because of having different Doppler center. The proposed method employs this character to separate moving targets from stationary targets. It can produce two images by pulse compression which make use of two symmetrical mismatch filters in azimuth direction, and then cancel stationary and retain moving targets by subtracting one image from another. Compared with traditional methods, it is applicable to both low and high squint case and the detection capability is significantly improved. The simulation results validate the effectiveness of the proposed method. [C74]

"Distributed GOSCA-CFAR Detection Based on Automatic Censoring Technique"

This paper present a new distributed constant false alarm rate (CFAR) detector based on automatic censoring technique. In the scheme, every local decision of individual detector, resulting from the comparison between its sample level and the estimation of the background based on GOSCA-CFAR (generalized order statistic, cell averaging-CFAR) algorithm, takes the value zero or one. Then, the fusion center makes the final decision utilizing the total local decisions, which are transmitted from each local detector. The overall decision, which is zero or one, is obtained at the data fusion center based on "AND", "OR", and "k/N" fusion rule. The results show that for the nonhomogeneous background caused by multiple interfering targets, particularly in multiple target situation, it exhibits good robustness in distributed sensor network. Under Swerling 2 assumption, the analytic expression of detection probability and false alarm probability are derived. [C75]

"Track initiation in Monostatic-Bistatic Composite High Frequency Surface Wave Radar Network based on NFE model"

Though a Monostatic-Bistatic Composite High Frequency Surface Wave Radar Network (MBC-HFSWR Network) is established to cover the shortage of the monostatic radar, how to judge the real target update from the plausible measurements to initiate tracks quickly and accurately still remains a challenging problem. A novel method utilizing unconventional characteristics for track initiation is proposed in this paper, which uses more accurate information and avoids the problem of low detection precision of high frequency radar. A highly intelligent information fusion model which is a combination of Neural network, Fuzzy reasoning and Expert system (NFE model) is presented to solve the problem above and the validity of the provided method is demonstrated by Monte Carlo simulations. [C76]

"Millimeter wave interferometric radiometry for passive imaging and the detection of low-power manmade signals"

Millimeter wave detection and imaging is becoming increasingly important with the proliferation of hostile, mobile millimeter wave threats from both weapons systems and communication links. Improved force protection, surveillance, and targeting will rely increasingly on the interception, detection, geo-sorting, and the identification of sources, such as point-to point communication systems, missile seekers, precision guided munitions, and fire control radar systems. This paper describes the Naval Research Laboratory's (NRL) demonstration broadband passive millimeter wave (mmW) interferometric imaging system. In addition to limited active signal detection, the Ka-band system will provide the potential for detecting the passive signature of non-transmitting hostile systems along with a capability for meter-precision geolocation for imaged objects. The interferometer uses a distributed array of 12 antenna elements to synthesize a large aperture. Each antenna is packaged into an individual receiver, from which a baseband signal is recorded. The correlator is software-based, utilizing signal processing techniques for visibilities, and image formation via beamforming methods. [C77]

"Research on Early-Warning Detecting Tasks Re-scheduling and Sensor Resources Allocation Strategy of Midcourse Maneuverable Ballistic Targets"

Ballistic midcourse maneuverable targets bring huge challenge to early-warning detecting tasks. The incoming threats targets could be lost in detection range of sensors and early-warning detecting tasks may be failure, which retard the response of a ballistic missile defense system and the criticality of missiles would be increased. How can the Space-based early warning system detect and track the ballistic midcourse maneuverable targets in real-time is a new issue. In this paper, a early-warning detecting tasks re-scheduling and sensor resources allocation strategy based on multi-levels is designed, sensor resources allocation rapidly come true and satisfied the dynamics and real-time tracking requirements of detecting tasks, as well as the fewer adjusting amplitude to originally resources scheme. Finally, taking the space-based early-warning detecting task of maneuverable ballistic missile for example, by which the feasibility and efficiency of the strategy are explained and proved. [C78]

"A TBD algorithm based on improved Randomized Hough Transform for dim target detection"

For the detection of dim target, the track-before-detect(TBD) methodology has been employed to integrate the target's energy through a time sequence of frames. A TBD algorithm based on improved Randomized Hough Transform for dim target detection is proposed in this paper. This algorithm uses the sequence number of frames to make sure that the point pairs are selected randomly from different frames, avoiding the unreasonable situation that initiates target's track in the same frame data. Second, it also introduces a new vote method. Based on the minimum Euclidean distance criterion, this vote method finds the optimal parameter cell to vote, making the vote result better than traditional Randomized Hough Transform (RHT). In addition, we not only increase the poll of the optimal parameter cell but also update the corresponding parameter, avoiding the large deviation between the recovered track and the real track. By simulation, we conclude that this algorithm can detect dim target more speedily and accurately than traditional RHT, especially under the background of low Signal to Noise Ratio (SNR). [C79]

"A modified track-before-detect algorithm for radar weak target"

Track-Before-Detect (TBD) is an effective method for detection weak target. In TBD a doubted target is tracked through a time sequence of frames, and then the target's energy is integrated along the tracked trajectory to lead to detection. Therefore the key of TBD methodology is how to accurate tracking target. A novel TBD algorithm is proposed based on Modified Hough Transform (MHT) and Particle Filter (PF). Firstly trajectories that are possible true target path are initiated by the MHT to obtain the region of the target, after that, this region is provided to the PF as the prior knowledge. According to this prior knowledge the false trajectories are eliminated and target is detected by the PF. Simulation results show the proposed algorithm can detect and track the weak target as low as 3 dB SNR. [C80]

"A segmentation-based CFAR algorithm for subsurface targets detection in FLGPSAR"

Forward-Looking Ground Penetrating Synthetic Aperture Radar (FLGPSAR) has the capability of forming two-dimensional high-resolution images of subsurface objects from a standoff distance. This paper addresses the detection of subsurface targets, i.e. landmines, in FLGPSAR images. The conventional Constant False-Alarm Rate (CFAR) algorithm has been widely used in SAR image target detection, but its performance will degrade in subsurface targets detection because of the presence of interfering targets and clutter power transition. In this paper, a segmentation-based CFAR (S-CFAR) algorithm is proposed. The S-CFAR algorithm can remove the interfering targets or clutter power transition before estimating the parameters of the clutter background to achieve a better performance than the conventional CFAR algorithm. The real data processing results are given to validate the efficiency of the proposed method. [C81]

"A new waveform for range-velocity decoupling in automotive radar"

Radar sensors for automotive applications require extremely high performance figures in terms of measurement accuracy and time. LFMCW radar sensors have the advantages of high range resolution, but it will bring out ghost targets and missed targets in multi-target detection. This paper describes a new waveform combining LFMCW with SFCW pairing is proposed and discusses in detail to demonstrate the technical differences and advantages. [C82]

"Fast computation of cross ambiguity function for DTTB based passive radar"

A new method is proposed to calculate the cross ambiguity function (CAF) for digital television terrestrial broadcasting (DTTB) based passive radar. The Doppler frequency of the targets is much lower than sampling frequency. The cascade integrator comb (CIC) filter is utilized to realize the large change of sampling frequency. The interpolated second-order polynomials (ISOP) filter is used to compensate the passband droop caused by CIC filtering. A half-band filter is employed to get narrow transition band. And then a short point FFT is performed instead of the long point FFT. The experiment results and computation complexity are given compared with other methods. It shows that the proposed method doesn't affect detection and estimation performance, and the computation is reduced significantly. [C83]

"Multi-cycle signal processing based on Keystone transform in LFMCW radar"

In this paper a Keystone transform based MTD processing is proposed for multi-cycle signals to solve the MTRC (migration through range cell) problem in linear frequency-modulated continuous wave (LFMCW) radar. Analysis shows that MTRC is introduced by the linear coupling of fast time and slow time in multi-cycle beat signals. Resorting to the decoupling principle of Keystone transform and under consideration of the characteristics of beat signals, a transform expression is given, which is independent of target parameters. The relation between this transform and the direct motion compensation is further discussed, and a general applicable condition is derived. Simulation results testify the conclusion and the efficiency of the method. [C84]

"Cover page"

The following topics are dealt with: kinematics, compressive sensing radar imaging, discrete Hilbert transform, feature extraction, nondestructive testing, dynamic programming, STAP algorithm, spread spectrum communication systems, face detection, wireless sensor networks, signal denoising, anti-jamming, information fusion, game theory, shipborne radar echo, ad hoc networks, wavelet transform, Hough transform, wind farm power, acoustic echo cancellation, speed estimation, image enhancement, curve fitting, perceptron neural nets, statistic decoding algorithm, LDPC codes, diffraction tomography, video watermarking, pulse compression technique, image analysis, cognitive OFDM, analog signal, fault diagnosis, target recognition, adaptive beamforming, nonlinearity correction imaging, computer vision, image segmentation, mobile networks, synthetic aperture radar, Kalman filtering, hidden Markov model, support vector machine, network intrusion detection, network congestion control, mobile VoIP, intertial navigation, edge detection, image resolution, image reconstruction, power control, cognitive radio, speech processing, attibute reduction, routing protocol, and incremental learning. [C85]

"The exposed area analysis of Barrage-type Jamming to Bistatic SAR"

In this paper, jamming equation is established which based on working mode of Barrage-type Jamming to Bi-SAR, and the coverage region is derived under a certain J/S (Jamming-to-signal ratio) from Bi-SAR. In such circumstances, the radar receiver can detect the target area through mathematical method analysis, namely exposed area. Finally, maximal exposure area, absolute exposure area, possible exposure area and definite protected area are divided. [C86]

"Research on the model of Target's trail and the detection simulation of air-defense radar"

In the trace fusion system, it is the unitary way and high cost to get the data sources of air-defense radar. Aiming at those shortcomings, this paper gives a method to generate data based on the model of target's trail and the detection simulation of air radar. The emphasis is placed on the model of target's trail and the process of air-defense radar detection. Fist of all, the trail model is built up on the flight plane, and then converted into rectangular coordinates system. The radar detection model simulates the detection process to estimate whether the target can be found. The real-time trace data is obtained if the target is found. The experiments validated the models and algorithms. [C87]

"An improved particle filter based on 4D discontinuous measurements"

During the target detection of the airborne pulse Doppler (PD) radar, a 4D measurement comprised of range, azimuth, elevation and radial velocity can be obtained to track the target exactly. But the factors including the Doppler blind zone (DBZ) would result in discontinuous measurements which breaks the continuity of the target track. To be consistent with the practice, we constitute the 3D relative motion model between the airborne radar and the target based on moving platform, and deduce the character of the relative radial velocity in DBZ. According to this, an improved particle filter with relative maneuver detection is proposed. This algorithm is able to adjust the moving direction of the particles according to the type of maneuver, and maintain the tracking by predicting the possible region where the target reappear from the DBZ. The simulation results indicate the validity and feasibility of this method. [C88]

"On orthogonal waveform design for MIMO sonar"

MIMO sonar that transmits orthogonal waveforms via transmitter sensors is an emerging technology that has significant application potential. Compared to standard phased array sonar, orthogonal transform waveform can bring many advantages including improved angular resolution and multi-target detection ability. We derive in this paper a novel binary-phase waveform design coded by Gold sequences. This phase code is computationally efficient compared to other codes previously proposed in the literature. We provide some numerical examples to demonstrate the performances of the new code sequence. [C89]

"Feature extraction and selection for landmine detection using textures of Time-Frequency Representation"

Ground Penetrating Radar (GPR) is widely used in the probe of subsurface targets, in which the Time-Frequency Representation (TFR) approaches have been proved effective for GPR signatures. Since we can treat TFR results as 2-D images, texture analysis is an applicable way for image discrimination. In this study, we propose a target detection method based on TFR textures of GPR A-scans and then select 20 descriptors to interpret TFR image into texture features for decision. The mutual correlation and discrimination ability of the

descriptors are studied based on the comparative experiment. According to the results, it is clear that the twenty descriptors are redundant and can be grouped into three weak-correlated classes: 11 descriptors of the first class and 2 of the second one are helpful and recommended to use in texture discrimination while the rest can be discarded. [C90]

"FCM-based radar target detection in medium frequency signal of radar"

In radar target detection application fields, rich of information of targets may be included in medium frequency. Doppler shift caused by moving target is one of them. In this paper, Doppler shift and its Short Time Fourier Transform-STFT is analyzed and discussed. Since it is difficult to distinguish the Doppler shift of moving target even in frequency domain with STFF method, fuzzy C means clustering method is introduced to seek the two centers of the mixed signals in a radar scanning period. Using multiple radar scanning period, several centers can be determined by a center function using arithmetic mean filter. Finally the targets can be detected by threshold decision and calculated the detection probability. This algorithm is simple, easily to realize, with small computation burden and good target detection probability. [C91]

"The chaotic signal design for MIMO radar"

The study of multiple-input multiple-output (MIMO) radar has received much attention from researchers in recent years. It has many advantages over conventional phased radar in many ways such as anti-intercept of radar signal, low velocity target detection, and resolution. The signal design is an important problem for radar which decides the performance of radar. In this paper, the chaotic signal is employed to the MIMO radar application. Some preprocessed method is employed to make the signal has small Crest Factor (CF), large bandwidth. Some simulation is presented to show efficiency of proposed method. [C92]

"Study on MIMO radar velocity resolution"

Multiple Input Multiple Output (MIMO) radar is a novel radar technique developed recently. It has many advantages over conventional phased radar in many ways such as anti-intercept of radar signal, low velocity target detection, and resolution. In this paper, the signal model and signal processing for MIMO radar is studied. And then, a simulation platform is established with Matlab. Using this platform, the advantage of velocity resolution of the MIMO radar over conventional phased array is researched. [C93]

"Enhanced detection of planar retro-reflective arrays using polarization properties"

This paper presents a design concept to aid in the detection and tracking of objects in a cluttered environment at 26 GHz. Target tracking can generally be accomplished with the use of retro-reflectors which are able to return an incident signal back in the same direction with a radar cross section (RCS) that is independent of angle of arrival for a large range of incidence angles. [C94]

"Performance evaluation of subsurface target recognition based on ultrawideband short-pulse excitation"

Automated Target Recognition (ATR) based on Natural Resonance Frequencies (NRFs) embedded in Ultra Wideband (UWB) transient electromagnetic signatures have been extensively studied. To our knowledge, most studies concerning ATR using the E-Pulse technique are about radar targets in free space. Recent attempts have been made to apply the E-Pulse technique for subsurface target detection. In this paper, performance evaluation of a recently proposed subsurface target recognition technique based on the E-Pulse and Baum's transform under different signal-to-noise ratios (SNR) is considered. Examples of target recognition of three different perfect electric conductor (PEC) targets sited below a frequency-dependent lossy halfspace are presented. [C95]

"Feasibility study for IED detection using forward-looking ground penetrating radar integrated with target features classification"

In this paper, we examined the natural resonance frequency and polarization features of UXO-Like IED target in forward-looking GPR configuration. Based on the simulation results, we confirm that these feature not only exist but also measurable in the case of FLGPR. It is therefore, strongly suggested that these features be included in the target classification algorithms as they are expected to improve detection, increase stand off distance and minimize false alarm rate. [C96]

"Beamforming through a circular pipe with two open ends"

In this paper, beamforming through a circular pipe with two open ends has been demonstrated using the least squares approach. Through simulation it was shown that using three sources it is possible to steer the main beam of the radiation at the other end of the pipe. The simulation results were then confirmed through measurement results. This one-way beamforming concept can be extended in a straightforward way to two-way detection of a target. Thus it should be feasible to detect the bearing to a target when using a pipe as a propagation medium for through-wall radar. [C97]

"A novel method for limiting the amplitude of SAR images with the principal axis detection"

Amplitude limiting of SAR target is one important preprocessing procedure in SAR target recognition. Traditional amplitude limiting adopted simple threshold value and is usually sensitive to noise. In this paper, a novel method for limiting amplitude is proposed, which is based on the priori knowledge that normally the strong scatter points are nearby target's principal axis. First, target's principal axis and its center is detected with the strong scatter points, then the target area is estimated and the strong scatter points' amplitude are limited by a simple smooth process. Experiments on SAR image show that the proposed method can limit the amplitude of the strong scatter points and enlarge that of the weak scattering points well. [C98]

"Advanced through-the-wall radar imaging using spectral and wall estimation techniques"

Two techniques are introduced and combined to improve SAR imaging of TWR scenarios, namely wall estimation and spectral estimation imaging using MUSIC. It was shown that homogeneous walls can be eliminated from SAR images although a significant amount of clutter remains if the wall shows inhomogeneities. Furthermore, applying the MUSIC algorithm can significantly clear up the image and make the targets behind the wall more visible. In conclusion, both the described wall estimation technique and MUSIC imaging can enhance TWR images, allowing a clearer interpretation or building a more reliable basis for further processing like target detection. [C99]

"Three-dimensional through wall imaging using an UWB SAR"

A 3-D UWB SAR has been designed to detect the positions of the targets behind the wall and identify them as well. The beam scanning is based on the mechanical movement of the wideband Tx/Rx Vivaldi array. The system transceiver and 3-D microwave beamforming algorithm are introduced in details. An experiment is performed to recover the 3-D images of a human mock-up. The demonstrated 3-D imaging results have indicated the capability of accurately locating, tracking and identifying human beings behind the wall. [C100]

"A Gaussian particle filter for track-before-detect"

A novel track-before-detect algorithm is proposed to perform detection and tracking a weak target in radar measurements. Firstly, a Gaussian particle filter based track before detect is presented for tracking target. Secondly because of the Gaussian particle filter is only tracking algorithm and can not perform detection target, the likelihood ratio based the Gaussian particle filter is derived. Finally based on this deduction, sequential fixed size (FSS) likelihood ratio test (LRT) is used to detect target. Simulation results show that this novel algorithm can realized detection and tracking a weak target simultaneously, and the performance of detection and tracking is improved than the particle filter. [C101]

"Radar signatures of complex buried objects in ground penetrating radar"

The evaluation of radar signatures of buried objects for three experimental ground penetrating radar setups will be addressed in this paper. The contribution will present corresponding results and experiences. The performance of the imaging capabilities of the designed radar system will be assessed by reconstruction of complex shaped test objects, which have been placed within the ground. The influence of system parameters of the ground penetrating radar have been varied systematically in order to analyze their effects on the image quality. Among the modified parameters are the step size in transverse plane, height of the antenna over ground, frequency range, frequency points, antennas and varying instrument settings. A signal processing technique based on synthetic aperture radar has been applied on the measured raw data. The focus radius around a specific target has been analyzed concerning the compromise between image quality and processing time. The experiments demonstrate that the designed ground penetrating radar systems are capable for detection of buried objects with high resolution. [C102]

"Parameter estimation from a fraction of the period for a rotating target"

All the techniques developed for extracting micro-Doppler features for the past decade rely primarily on the assumption that the time series of the signal contains at least one oscillation or more during the coherent

integration time or imaging time. However, many applications in real-world scenarios involve short duration signals and often require the detection and the estimation of micro-Doppler characteristics. Short duration signals may contain only a fraction of an oscillation. In this paper, we develop two techniques to estimate the micro-Doppler parameters from a fraction of the period. In these scenarios, the coherent integration will cover only 1/4 and 1/2 of the oscillation. The performance of the proposed methods are evaluated using both synthetic and experimental data. [C103]

"Use of Digital-Television terrestrial (DTV) signals for passive radars"

Purpose of this paper is the description of how to use the Digital-Television terrestrial Video (DTV) stations as a non-cooperative illuminator in bistatic radar. Based on [1] it is shown that the original DTV signal contains random and deterministic components. Analyzing the ambiguity function of the DTV signals, it is found that the deterministic components cause unwanted peaks around the desired peak pertaining to the useful echo thus the target detections is difficult to do and/or false targets can be revealed. In this paper, a new approach to improve the ambiguity function around the useful echo will be proposed. In order to study, evaluate and elaborate the DTV signal, a simulator of the complete signal was performed This paper is organized as follows: next section 1 will describe the obtained outputs of DTV simulator; section (2) will describe the complete block diagram of passive radar using DTV signal, describing the new signal processing approach to improve the ambiguity function; section (3) will describe the obtained results from a realistic scenario; section (4) will present some preliminary results about the multipath effect on the system performance. [C104]

"Software for simulation of electromagnetic waves propagation through the soil with buried objects"

The software for simulation of electrmagnetic waves propagation through the soil layered structure with shallow buried objects has been described in the paper. The simulation is based on the finite difference time domain (FDTD) method and allows to define ten layers of soil and four buried cubicoid objects. Such virtual ground penetrating radar (GPR) system seems to be useful for test of targets detection level for different soil structure configurations as well as different transmitted radar signals and scanning methods. [C105]

"Fast segmentation of 3D point clouds for ground vehicles"

This paper describes a fast method for segmentation of large-size long-range 3D point clouds that especially lends itself for later classification of objects. Our approach is targeted at high-speed autonomous ground robot mobility, so real-time performance of the segmentation method plays a critical role. This is especially true as segmentation is considered only a necessary preliminary for the more important task of object classification that is itself computationally very demanding. Efficiency is achieved in our approach by splitting the segmentation problem into two simpler subproblems of lower complexity: local ground plane estimation followed by fast 2D connected components labeling. The method's performance is evaluated on real data acquired in different outdoor scenes, and the results are compared to those of existing methods. We show that our method requires less runtime while at the same time yielding segmentation results that are better suited for later classification of the identified objects. [C106]

"Methods of target recognition for UWB radar"

With the growth of embedded components (GPS, radar, cameras...), road vehicle becomes more and more intelligent and reassuring. The concept of the intelligent vehicle is to make it able to analyze, individually and independently, the external data before transmitting them to the driver. In recent years, ideas for studies and research programs on this concept have proliferated in different environments. The cars now have tools to control speed, manage traffic and ensure the avoidance collision task. A radar, that allows to detect obstacles in the road environment and to alert the driver, is one of the very powerful devices, even essential to ensure the safety of road users. This device has the advantage of being effective anytime (fog, rain...). The arrival of Ultra Wide Band (UWB) technology for radar application allows the development of compact and relatively cheap sensors. Dedicated to military applications, radar devices using UWB are now a good tool of detecting obstacles for many applications in life everyday. These sensors could be used to measure distances and positions with greater resolution than existing radar devices or to obtain images of objects buried underground or placed behind surfaces. This paper is focused on the study of UWB radar signatures to identify the type of obstacles. [C107]

"A simulation tool for analysis of MTD algorithms employing STAP techniques"

The purpose of this work is development and program realization in MATLAB computational environment of a tool suitable for modeling and evaluating the performance of a pulse doppler MTD (Moving Target Detector) radar with LFM (Linear Frequency Modulated) signals employing STAP (Space Time Adaptive Processing)

techniques. It supports numerical design choices with selectable system and signal processing parameters so that different designs can be traded-off or optimized. This software tool is also able to simulate selectable target, clutter and jamming and thus particular scenarios of interest can be evaluated. The obtained results can be a good base for real time implementation. [C108]

"Ka-band radar sensor with selection of moving targets for airport surface monitoring"

The paper describes the peculiarities of the technical solutions, operation characteristics and results of the field tests of a prototype of the semiconductor Ka-band radar sensor with a coherent signal processing designed to be used as a part of the surface monitoring system at airports. The prototype have been developed, fabricated and tested by IRE NASU (Kharkov, Ukraine) and OJSC SPE «Saturn» (Kiev, Ukraine). [C109]

"Quantization effect of the parameter space on the performance of hough detector"

Hough transform is proposed in literature as an effective technique for target detection in search radars. However, this detector has a disadvantage when the received SNR of radar is low. Although the distribution of noise power in the data space is often uniform and all processing cells of this space approximately receive the same power of noise, after transforming these cells to the Hough parameter space, this distribution will not remain uniform. In other words, noise power in some regions of the parameter space is greater than the others. Therefore, false alarm increases in these regions. Selecting a greater threshold to reduce the number of false detections will result a lower probability of detection in lower SNR cases. In this paper, a new quantization method is used for the parameter space which is based on the Maximum Entropy Quantization. It is verified through simulation results that by using this method, the distribution of noise power in this space will become uniform and the average probability of false alarm will be the same for all parameter cells. Also, the performance of Hough detector with a non-uniform quantized parameter space is compared to uniform quantized one through simulation scenarios and it is shown that an improvement of about 2dB results in the required SNR. A method is also introduced to solve the above mentioned problem of the Hough detector for the cases in which the distribution of noise power in the data space is not known. [C110]

"Microwave visualization of layered dielectric half-space using range profiling of phase"

A novel method of subsurface radar data processing based on independent determination and representation of amplitude and phase profiles is described. As the phase of the reflected signal depends on dielectric properties of buried target, the proposed technique is suitable for target discrimination. The amplitude and phase information is merged in the common image by governing intensity and color of the image. The amplitude profile of the reflected signal is obtained using a standard inverse Fourier transform of the frequency domain data whereas the phase profile associated with the reflection act at the given depth is derived using a special data processing technique. Some numerical and experimental examples illustrating the method performance are presented. [C111]

"One Example of classing and extracting information from GPR images for the archeology"

Ground penetrating radar (GPR) techniques are based on the possibility of sending electromagnetic pulses and registering of the signals back-scattered by the interface between propagation media of different dielectric permittivity. They had been successfully using to examine structures and materials from inside. In the studying, GPR sounding is practically used for detection and reconstruction of the fortification objects. The software for increase of efficiency of archeological researches and reduction of expenses was developed. The GPR method is practically approved for the undersurface environment monitoring for the archeology-interested zones by results of experimental and practical investigations. The estimation of GPR efficiency at monitoring researches, time and expenses on engineering-archeological works were carried out. As a result of researches, contours of fortifications sites are restored. Contours of the stone bases under dwellings are found out and restored. The investigation aims at expounding some preliminary results drawn by specific algorithms for automatically interpreting, classing and extracting explicit information from radar images. [C112]

"Data fusion algorithms for sea target tracking using coastal radar model"

The fusion of multiple monitoring systems data is very important, to get a full view of situation in coastal waters. Sea target tracking algorithm is modeled, coast radar system model implemented, multiple ships tracking and detection is tested. [C113]

"Utilizing Adaptive Techniques to Supress Noise In High Frequency Ground Wave Radar"

Reducing noise disturbances in the frequency segment of high frequency (HF) ground wave radar and

restraining the sidelobes of strong targets that interfere with the detection of weak targets are the interesting Topic. A new method based on an adaptive techniques that solves these problems is proposed. By changing the working time of the frequency spectrum monitor (FSM), we have shown not only that radar can run in the frequency segments with lower noise disturbances, but also that the noise data produced by FSM can be exploited effectively. There is no correlation between the noise and the useful echo signal, though the correlation between noises over very short time periods is strong, . Exploiting the phenomena, we can adjust system parameters in real-time by adaptive methods to solve the two problems, namely sidelobe disturbance of strong targets and noise distrubance in the frequency segment. [C114]

"Performance analysis in heterogenous environment and implementation on DSP processor of a GOWMAX CFAR detector"

In this paper we present the results of performance analysis of a GOWMAX CFAR detector in non homogenous environment. The study is made for radar targets of Swerling I type embedded in white Gaussian noise. The results are presented in terms of probability of detection and false alarm. Also we expose the algorithm considered and the results obtained for its implementation on DSK 6711 card using a DSP TM320C6711 processor. [C115]

"Object tracking via the probability-based segmentation using laser range images"

In this paper, a probability-based segmentation approach is presented for object tracking. The proposed approach uses the Dirichlet process mixture model to describe the probabilistic distribution of observations in a single scan of a laserscanner. Then the number of segments is inferred from the observations by the Gibbs sampling method. Moreover each segment is classified into one of the three predefined classes such that most of non-vehicle-like objects on the roadsides can be filtered out. Then, the tracking algorithm, called Joint Integrated Probabilistic Data Association Filter (JIPDAF), is applied to track the classified objects and manage existing tracks. Simulations based on real traffic data demonstrate that the non-vehicle-like objects on the roadsides are suppressed. Since the number of objects in the tracking step is decreased, the computation load of the tracking step is decreased. [C116]

"Automatic classification of metallic targets using pattern recognition of GPR reflection: a study in the IAG-USP Test Site, Sao Paulo (Brazil)"

In this work, a methodology to automatically classify of metal targets using pattern recognition techniques on GPR reflection data is presented. The methodology consists of designing a multilayer perceptron (MLP) classifier based on features extracted from the targets in the subsoil, and then using it to classify hyperbolas diffraction indicating their position and depth. The classification of reflections allows a high resolution reconstruction of the subsurface with reduced computing time. The system was developed in MATLAB and applied to GPR data obtained at IAG-USP test site, located in the city of Sao Paulo, Brazil, where metallic drums were studied under controlled field conditions. This site contains different targets of variable sizes buried under different depths and it served as a model for the computational experiment. The results indicate that the automatic classification of the metallic targets in the subsoil is efficient, contributing for the reduction of the ambiguities in the geophysical data interpretation, besides having application on the subsoil mapping of utilities. [C117]

"Textile antenna for the multi-sensor (impulse GPR&EMI) subsurface detection system"

The performance of a planar elliptical dipole textile antenna for the multi-sensor (impulse GPR&EMI) subsurface detection system is investigated. This is a new application of textile antenna. The textile material of antenna does not create an EMI clutter comparing solid Cu material. The antenna characteristics of the proposed antenna in the multi-sensor head are measured and compared with the simulated ones. A buried target into soil, is successfully detected by the multi-sensor system with the usage of the textile antenna in the GPR sensor. [C118]

"A novel detection warning signal creation method for hand-held GPR applications"

In this paper a novel detection warning signal creation method is proposed for pulse Ground Penetrating Radar (GPR) data, especially for small non-metallic targets, in time domain. Background removal is applied to the data through a sliding window scheme and Target Energy Function (TEF) is obtained as correlation summation of consecutive A-scan signals. Then Auxiliary Detection Function (ADF) is defined and a novel automatic Detection Warning Signal (DWS) creation is applied. The proposed method has been tested specifically for a set of small sized dielectric targets which are not easily detectable. The results are promising as full detection performance and zero false alarm rate in original dataset. Moreover, it is obtained that the immunity of the proposed method

against noise is very satisfactory. [C119]

"Development of a bore-head GPR for Horizontal Directional Drilling (HDD) equipment"

ORFEUS is a Specific Targeted Research Project (STREP), partly funded by the EC, that started in November 2006. One of the objectives of the project was to design and develop a radar mounted on the drill head of Horizontal Directional Drilling (HDD) machines to provide a real-time indication, to the operator, of obstacles in the drill path. The system consists of a GPR control unit (housed in a drilling rod) and two UWB antennas. These can detect buried infrastructure that the bore-head may strike and verify a clearance zone around the drill string to ensure that new pipes may be installed with a minimum separation from adjacent plant. During the 3 year project, several key technical problems, mainly concerning electromagnetic and mechanical compatibility issues, have been solved. The system was finally tested both in experimental and operational sites. These tests confirmed the capability of the equipment to provide useful information on the obstacles in the drilling path; detection range has been evaluated to be sufficient to generate a warning message to the operator to allow corrective action to be taken, thus enabling HDD equipment to be used in greater safety. [C120]

"Space-time adaptive processing for sea clutter and jamming suppression in radar seekers"

When radar seeker searches and tracks moving target on sea surface, sea clutter spectra severely spread out due to the strong effect of sea conditions. Conventional methods for suppressing sea clutter have achieved poor performance. This paper mainly analyzes the sea clutter characteristics in azimuth-Doppler domain and clutter spectra with different scanning angles. Then space-time adaptive processing (STAP) technique is applied to suppress sea clutter. Research results indicate that sea clutter spectra have some special characteristics in space-time distribution, and the proposed STAP algorithm can detect slow moving targets effectively as it can suppress sea clutter and strong jamming. [C121]

"Application of ground penetrating radar in the urban environment"

Several nondestructive testing methods have been studied to detect subsurface voids. However, few focus on deploying nondestructive methods in the congested and complex subsurface environment found in typical urban locations. This research identifies the challenges with applying Ground Penetrating Radar (GPR) techniques to locating subsurface voids and buried infrastructure in a complex urban environment. The study cataloged GPR signals representing reinforcements, concrete pipes, trolley tracks, and a large range of subsurface voids from surveys collected in downtown Louisville, Kentucky. Building upon this research, the team recreated a typical subsurface urban environment on the University of Louisville campus to develop a library of GPR images taken from known targets with defined parameters for training purposes. [C122]

"The shrine of edward the confessor: A study in multi-frequency gpr investigation"

Following an earlier investigation into the 13thCentury Cosmati mosaic in Westminster Abbey, Ground Penetrating Radar (GPR) investigations were commissioned in order to locate the site of a large royal tomb. Antennas of 400MHz and 4GHz frequency were used in the area of the High Altar steps and on the floor of the current Shrine Chapel. The investigation uncovered evidence of the target tomb, a number of other graves, some previously unknown, and at least one buried object. The paper briefly discusses the frequencies selected and illustrates how these have resulted in better understanding of the archaeological and historical evidence. [C123]

"Target vehicle selection based on multi features fusion method"

A target selection method based on multi features fusion is proposed to improve the accuracy of target vehicle selection. The parameters consisting of the longitudinal distance, lateral distance, relative speed between objects and the host vehicle, the in-lane probability of objects are regarded as the features of individual vehicles. Firstly, some pre-processes of features data are carried out including Distance Compensation Factor (DCF) correcting and Kalman filtering, which are used to correct the in-lane probability data provided by lidar, track and predict the relative distance and speed of objects to lower the missing rate of vehicle detection respectively. Furthermore a two-layer BP neural network is designed to train the sample data and obtain the importance weight of feature variables; the training output is finally utilized as the index for target recognition. The selection method utilizes the valid information collected by sensors through the fusion of multi vehicle features. Experiments show that the vehicle detection results can be improved and the target selection and tracking accurately can be fulfilled through the proposed method. Even under cut-in conditions, the target can also be switched to the cut-in vehicle in time. [C124]

"Efficient occupancy grid computation on the GPU with lidar and radar for road boundary detection"

Accurate maps of the static environment are essential for many advanced driver-assistance systems. In this paper a new method for the fast computation of occupancy grid maps with laser range-finders and radar sensors is proposed. The approach utilizes the Graphics Processing Unit to overcome the limitations of classical occupancy grid computation in automotive environments. It is possible to generate highly accurate grid maps in just a few milliseconds without the loss of sensor precision. Moreover, in the case of a lower resolution radar sensor it is shown that it is suitable to apply super-resolution algorithms to achieve the accuracy of a higher resolution laser-scanner. Finally, a novel histogram based approach for road boundary detection with lidar and radar sensors is presented. [C125]

"A fusion method of data association and virtual detection for minimizing track loss and false track"

In this paper, we present a method to track multiple moving vehicles using the global nearest neighborhood (GNN) data association (DA) based on 2D global position and virtual detection based on motion tracking. Unlikely the single target tracking, multiple target tracking needs to associate observation-to-track pairs. DA is a process to determine which measurements are used to update each track. We use the GNN data association not to lost track and not to connect incorrect measurements. GNN is a simple, robust, and optimal technique for intelligent vehicle applications with a stereo vision system that can reliably estimates the position of a vehicle. However, an incomplete detection and recognition technique bring low track maintenance due to missed detections and false alarms. A complementary virtual detection method adds to GNN method. Virtual detection is used to recover the missed detection by motion tracking when the track maintains for some periods. Motion tracking estimates virtual region of interest (ROI) of the missed detection using a pyramidal Lukas-Kanade feature tracker. Next, GNN associates the lost tracks and virtual measurements if the measurement exists in the validation gate. Our experimental results show that our tracking method works well in a stereo vision system with incomplete detection and recognition ability. [C126]

"Levy flights for improved Ladar scanning"

A new approach has been used to improve Ladar performance in real time applications based on the use of Levy statistics. This approach speeds up target detection and does not require a full scan of the field of view and the subsequent data processing. This leads to a more efficient Ladar system and opens up the possibility for more real time applications. The approach is to use "Levy flights" instead of traditional techniques, such as Raster and Lissajous scanning, to detect the target in the scene. The performances of these latter techniques and this new approach are compared for a variety of conditions. The simulation results show an enhanced performance when using Levy flights as a scanning technique. [C127]

"GPR as an imaging device: Some problems & potential solutions"

Ground Penetrating Radar (GPR) is an invaluable tool in a wide range of applications. In each sphere of activity to which the technology is applied, however, there is a tension between gaining meaningful information and the time and resources committed to data collection, processing and interpretation. In the light of the current world economic crisis, this is not likely to ease. [C128]

"Non-destructive technique to investigate an archaeological structure: A GPR survey in the Domus Aurea (Rome, Italy)"

The discovery and touristic fruition of the Domus Aurea (Latin for "Golden House"), and the heavy rain led to the arrival of moisture, starting the slow and inevitable process of decay and collapse. Furthermore, inside the Domus Aurea, there are a lot of parts not yet excavated, attracting a continuous and archaeological interest. In order to properly plan the restoration of this building and detect buried archaeological features, a non-destructive technique, like Ground Penetrating Radar (GPR), is extensively and profitably used for its rapid data collection and its high resolution images of contrasting subsurface structural or archaeological materials. The results show not only the presence of internal lesions and detachments of the wall and vault structure, but also the existence of buried archaeological targets; these preliminary results allow future restoration plans in order to prevent the rapid degradation of this important building. [C129]

"Effects of iron pipe corrosion on GPR detection"

Many studies into the use of GPR to detect targets assume that the targets are ideal reflectors. In reality most targets have been in the ground for many years and have settled and suffered some contamination or corrosion. Iron pipe in particular can be hard to find with GPR. Some possible corrosion processes suggest that a varying conductivity and permittivity profile may be established around a pipe. The consequences of such corrosion induced profiles are that the radar return may be greatly diminished in the classic look-down GPR mode of operation. The analysis shows that the novel look through GPR mode of operation is affected far less by the

corrosion induced profiles. [C130]

"Using an FPGA digital clock manager to generate sub-nanosecond phase shifts for lidar applications"

When using a Light Detection and Ranging (LIDAR) gun for civil engineering applications, anomalous data were observed. A laboratory system was developed to simulate ranging to moving targets in a controlled environment in order to study the anomalous data and the performance of the LIDAR gun. The laboratory system was found to require the ability to generate sub-nanosecond phase shifts which can be updated in real time. This capability is available in high-quality laboratory, but the required equipment was not available to the authors. This research examines the design and implementation of a low cost system. The final design uses an embedded processor for computation of the necessary phase shifts and possible anomalies and an FPGA system to generate the dynamic precision phase shifts. [C131]

"Weak signal enhancement in radar signal processing"

In through wall tracking of multiple targets it is able to detect many times only a target moving closest to the radar antenna system. It results from the fact that the reflections from targets located further from the radar antennas are very week in comparison to that target. The methods for weak signal enhancement can solve the outlined problem. In the paper, three such potential methods are described and tested on real radar signals. The achieved results confirm their ability to enhance the weak signal components with low computational complexity. [C132]

"CFAR detectors for through wall tracking of moving targets by M-sequence UWB radar"

In this paper different CFAR detectors for detection of multiple targets for UWB radar system will be described. In this paper, the cell averaging CFAR (CA-CFAR) cell averaging with greatest of (CAGO-CFAR) and ordered statistics CFAR (OS-CFAR) will be represented. The detectors outputs will be illustrated and compared. The properties of all detectors will be illustrated by real radar signal processing obtained by the measurement with the M-sequence UWB radar. [C133]

"A stochastic-gradient method to design optimal space-time codes for MIMO radar detection"

We consider a MIMO radar system with widely-spaced transmit/receive antennas and study the problem of designing the signal waveforms transmitted by each source node so as to maximize the detection probability for a fixed false alarm rate under correlated Gaussian clutter. The proposed design procedure relies on a stochastic-gradient search and is general enough to be applied to any statistical target model. Examples are provided to compare the performance of the proposed codes with other known coding schemes. [C134]

"A novel algorithm of coherent integration for moving target detection"

The problem of detecting moving targets which migrate between rang cells is considered. The traditional MTD method can not effectively integrate the energy of targets, because it integrates multi-pulse in the same range cell in a CPI. This paper introduces a novel algorithm of coherent integration for moving target detection (MTCI), which is calculated along the track of the moving target. A mathematical formula of MTCI algorithm is derived based on the signal model of a moving target in Chirp Radar. The integrating results of MTCI and MTD methods in the Gaussian white noise background are also compared. A Monte Carlo simulation has been performed to evaluate the detecting performance of MTCI algorithm, and the detection curves are also given. [C135]

"Using full motion 3D Flash LIDAR video for target detection, segmentation, and tracking"

It is now the case that well-performing flash LIDAR focal plane array devices are commercially available. Such devices give us the ability to measure and record registered 3D point cloud sequences at video frame rates. For target detection and tracking applications this allows the processes of structure from motion or multi-view stereo reconstruction to be circumvented. This allows us to construct simple and robust real-time 3D detection and tracking systems. The goal of this work is to demonstrate for the first time a proof-of-concept system using a commercial 3D Flash LIDAR camera. The system will accomplish the detection, segmentation, and tracking of human sized objects using a combination of fundamental point cloud processing algorithms. With marginal refinement efforts the result of this work is directly applicable to perimeter surveillance and site security. [C136]

"A Hotelling T-squared GIP test for detection of over resolved targets"

A new technique for detection and discrimination of stationary or slow-moving over-resolved targets on the

ground, based upon a Hotelling T-squared test/generalized inner product (GIP) approach to signal analysis is presented. This robust detector separates radar returns from interference via a coherent process. This GIP-based processing can be applied to single-receiver channel systems, multiple spatial channel systems, multiple polarization channel systems or systems with multiple spatial and polarization channels. [C137]

"Small target detection in SAR image using the Alpha-stable distribution model"

The Constant False Alarm Rate (CFAR) algorithm is most commonly used for small target detection in SAR images. As the goodness-of-fit of distribution model to SAR clutter has great effect on the performance of algorithm, after a comprehensive statistical analysis of background clutters of different SAR data, a modified CFAR algorithm based on the Alpha-stable distribution is proposed for detecting small targets in SAR images, especially under the extremely inhomogeneous background clutter. Considering for the complexity of Alpha-stable distribution model, the parameter estimation and threshold determining steps of the modified algorithm are introduced in detail. Performance of the algorithm is assessed by experiments on ADTS data. Compared with typical two-parameter CFAR (TP-CFAR) algorithm based on Gaussian distribution and K-CFAR algorithm based on K distribution, the proposed method is demonstrated to be most suitable for detecting small target in extremely inhomogeneous regions. [C138]

"Study on adaptive monopulse with reduced dimension STAP technique"

For airborne radar, the estimation performance of moving target parameters is greatly affected by the residuals of ground clutter after space-time adaptive processing (STAP). The non-homogeneity of environment, which results in the lack of available secondary data, will make this problem worse. In this paper, a novel method, which utilizes small amount of secondary data, is proposed for getting more accurate estimation under non-homogenous environment. In this method, the spatial and temporal dimensions are reduced properly for the benefit of low secondary data support and exact clutter covariance matrix estimation; additionally, by combining a STAP processor with monopulse technique, target parameters will be obtained. The simulation results are shown this method is more accurate and adaptable than the previous adaptive monopulse with STAP method under the non-homogeneous environment. [C139]

"Detecting and tracking of small moving target in avian radar images"

A sequence of plane position indicator (PPI) images containing a small moving target is collected using an experimental avian radar surveillance system, which is constructed by modifying a standard marine radar. Smoothing trajectory of a small moving target is separated from the image sequence after background subtraction, clutter suppression, measurements extraction and tracking. The background image is generated by Fast Independent Component Analysis (FastICA). Low segmentation value is set in clutter suppression to improve detecting rate at the cost of introducing a great deal of clutters. Therefore, false alarm rate need to be reduced by tracking. Meanwhile, a modified Hough transform method is applied for track initiation. Monte Carlo data association is proposed for track maintenance and Kalman filtering is adopted for target state prediction and update. Finally, the trajectory is smoothed and then fused with a satellite map for further observation. [C140]

"Modified combination rule of D-S evidence theory"

For solving information fusion problem of inequality important information in integrated target recognition the concept of evidence weight is introduced based on D-S reasoning. For transformation of each evidence according to its weight difference the evidence synthesis is completed using tradition method in integrated target recognition of different grade using this method the problem of target recognition of only same grade sensor using tradition evidence theory can be solved. An identification example using this method indicates that the precision and effectiveness of target recognition are raised. [C141]

"Target localization by a multistatic UWB radar"

Moving target localization and tracking are of great interest for rescue, surveillance and security operations. The radar signal processing procedure providing the target position estimation consists of such phases of signal processing as raw radar data pre-processing, background subtraction, detection, time of arrival estimation, localization and tracking. In this paper, we will focus on the localization phase where we assume that for the target localization UWB radar equipped by one transmitting and N receiving antennas is used. Following this intention, the accuracy of the target localization provided by the least-squares method, the spherical-interpolation method and the Taylor series method applied within localization phase will be compared based on processing of radar signals obtained from real target tracking by UWB radar. The acquired results confirm that the Taylor series method can provide the best accuracy of the target positioning. [C142]

"Acquiring probability computing model of anti-ship missile based on present position shooting mode"

When anti-ship missile adopts present point shooting mode, the computation of the firing data only needs to shoot at target present position without considering target movement and measuring target states during the programmed flight period. Thus the factors that influence the acquiring probability increases and the traditional methods can not reflect the influence of the error on the acquiring probability completely. In this paper, the main error are integrated as target indication precision error and lateral deviation. Different from the traditional methods, target maneuvering limit and target indication accuracy error are both considered as circular distribution. By using analytic method, the computing models of the acquiring probability for anti-ship missile on conditions of different error are built. Finally, the acquiring probability of anti-ship missile with high velocity of sound has been simulated. The results show that two kinds of error both have obvious influence on the acquiring probability. According to the standard that acquiring probability should not be less than 0.99 from the tactics and the demand of the azimuth searching range and target indication accuracy error and lateral deviation of anti-ship missile has been obtained which can be referred by the parameter design of anti-ship missile. [C143]

"A velocity estimation method for Multi Carrier Phase-Coded radar"

Due to good balance among spectrum efficiency, ambiguity function and peak-to-mean envelope power ratio (PMEPR), wideband Multi-Carrier Phase-Coded (MCPC) radar has caught much attention from researchers recently. Based on separation of sub carriers from multi-frequency structure, this paper provides velocity estimation method for such radar signal. After detecting the peek Doppler spectrum of each sub carrier, the unambiguous velocity can be obtained by Least-Squared (LS) algorithm. The simulation results show that these methods can estimate the velocity of fast-moving target efficiently and guarantee the accuracy against low SNR. [C144]

"Probability hypothesis densities for multi-sensor, multi-target tracking with application to acoustic sensors array"

Random sets theory offers a uniform framework for the multi-source data fusion, and all problems of the data fusion could be describe, analyzed and solved in this framework. The multi-sensor multi-target tracking problem could be natural represented in the framework. It is of engineering importance to tracking low altitude moving targets with acoustic methods due to the blindness of the traditional radar detecting. In this paper, an algorithm for tracking the low altitude or ground moving targets is put forward based on the Probability Hypothesis Density (PHD) Filter. The PHD Filter based on Finite Set Statistics doesn't need consider data association for multi-target tracking, which propagates the PHD or first moment instead of the full multi-target posterior, and it could estimating the unknown and time-varying number of targets and their states under clutter environment. In the practical, we use the Sequential Monte Carlo (SMC) method to approximate the PHD. The paper presents a novel and fundamentally well-grounded framework for tracking multiple acoustic targets using PHD Filter and passive acoustic localization technique. Simulations are also presented to demonstrate the performance in tracking a randomly varying number of targets in a clutter environment. [C145]

"Airborne GMTI using MIMO techniques"

The performance of a ground moving target indicator (GMTI) radar is strongly driven by the length of the radar aperture, as longer apertures enable lower minimum detectable velocity (MDV) and better target geolocation. Multiple-input multiple-output (MIMO) techniques can enable the use of long sparse array geometries while avoiding the adverse sidelobe effects typical of such arrays. In 2009 an experiment was conducted at Ft. Devens, MA to collect MIMO GMTI data on instrumented ground targets. A reconfigurable S-band antenna array was programmed to transmit both conventional single-input multiple-output (SIMO) and MIMO waveforms. Analysis of the data indicates improved detection performance with the MIMO techniques compared to the conventional SIMO approach. [C146]

"Waveform interference mitigation for a shared spectrum MIMO radar system"

MIMO radars may outperform conventional ones as regards target detection, parameter estimation and classification via spatial and waveform diversities. MIMO radar is a kind of shared spectrum system: the mutual interference among the waveforms may lead to considerable performance degradation, especially with multiple targets. As a result, preserving MIMO radar performance under such conditions via waveform design becomes an interesting research topic. In this paper, we consider the marriage of space time coding (STC) and Golay complementary pairs to mitigate both waveform autocorrelation and cross-correlation effects, and hence to enhance range resolution. The implementation is discussed, and an application for instantaneous polarization is

briefly introduced. [C147]

"A Bayesian filtering algorithm in jump Markov systems with application to track-before-detect"

Track-before-detect (TBD) aims at tracking trajectories of a target prior to detection by integrating raw measurements over time. Many TBD algorithms have been developed in the literature, based on the Hough Transform, Dynamic Programming or Maximum Likelihood estimation. However these methods fail in the case of maneuvering targets and/or non straight-line motion, or become very computationally expensive when the SNR gets low. Other techniques are based on the so-called switching or jump-Markov state-space system (JMSS) model. However, a drawback of JMSS is that it is not possible to perform exact Bayesian restoration. As a consequence, one has to resort to approximations such as particle filtering (PF). In this paper we propose an alternative method to approximate the optimal filter, which does not make use of Monte Carlo approximation. Our method is validated by computer simulations. [C148]

"SMRF architecture concepts"

This paper presents three valuable applications of scalable multifunction RF (SMRF) systems. These systems allow radar, ESM and communication functionality using a single front-end architecture. With the use of a novel system design tool, concepts for SMRF architectures for airborne, ground-based and naval application have been obtained based on a CRAM scenario. [C149]

"Modeling and simulation study on radar Doppler signatures of pedestrian"

This paper focuses on radar Doppler signatures of pedestrian. Firstly, an improved human walking model which describes a pedestrian as a linear-rigid target is introduced. Then radar echoes of the pedestrian under the condition of continuous wave (CW) radar signal are acquired, formulas of instantaneous Doppler are derived and movement signatures of the target are analyzed. Simulation experiments are carried out to validate the model and theoretic analysis. [C150]

"A novel method to detect rotor blades echo"

In this paper, the effect of the main rotor of an armed helicopter on radar return signal and its modulation condition are considered. After analyzing references and experimental data, this paper proposes a new method based on inherent modulation in main rotor echo. This method is able to enhance the probability of detection. The simulation is performed for both simulated and practical echo signal. Simulation results confirm that our proposed scheme is effective. Moreover, a new domain for distinguishing and measuring the rotation feature of a rotary target is proposed. This paper is based on practical experiments (rotation domain). [C151]

"Preliminary results of ultra-wideband through-the-wall life-detecting radar"

It is often a difficult task of knowing the location or movement of people behind barriers. To address this problem, we develop a through-the-wall life-detecting radar (TWLDR) prototype. It is a kind of ultra-wideband (UWB) radar using impulse waveform, which can penetrate non-metallic walls to detect static and moving targets behind walls. We first introduce configurations of the radar system, then describe signal processing techniques, and present experimental results in different situations at last. Results indicate that the UWB TWLDR can penetrate non-metallic walls to detect people with different locomotion states such as standing, walking along cross-range direction, walking along range direction, and the signal processing algorithm could be applied to other complex environments. [C152]

"Modeling and Simulation of Adaptive Thresholding in Marine RADARs"

In order to detect targets upon sea surface or near it, marine radars should be capable of distinguishing target reflections from the sea clutter. Our proposed method in this paper relates to detection of dissimilar marine targets in an inhomogeneous environment with clutter and non-stationary noises, and is based on adaptive thresholding determination methods. Variation and mean vales of the noise have been estimated in this paper, based on non-stationary, statistical methods and thresholding has been carried out using the suggested two-pole recursive filter. Fixating the rate of false alarm, the concerned threshold resolves the assumption problem of existence or absence of the signal. Performance of the mentioned algorithm has been compared with method known as CA-CFAR in terms of decreasing the losses and increasing calculation speed. The algorithm provided for detection of signal has been implemented at the end of signal-processing algorithms of sea marine radars. The results obtained from the algorithm performance in a real environment indicate appropriate workability of this method in heterogeneous environment and non-stationary interference. [C153]

"Modeling and Simulation of Trajectory in RADAR Systems"

In order to present a general structure for different maneuvers of targets, in this paper we have studied and simulated models implemented for targets trajectory in one, two and three-dimensional forms, for maneuvering and non-maneuvering targets. As an innovation, effects of detection and false alarm probabilities have been applied to simulations and are used for radar tracking system performance evaluation. Also, radar system accuracies and errors are imported to the simulations to make real situation for maneuvers. For all the presented models, trajectory simulation has been done and errors evaluated, and the results have been shown in diagrams in the end of paper. The results can be used for evaluating different tracking algorithms in different SNRs and are basis of comparison between different tracking algorithms in different detection and false alarm probabilities and system errors. [C154]

"A real-time FPGA-based implementation of target detection technique in non homogenous environment"

This paper presents a high speed real-time target detection system for non homogenous environment based on FPGA Technology. The system implements a Backward Automatic Censored Ordered Statistics Detector (B-ACOSD) to maintain a Constant False Alarm Rate (CFAR) for Radar system with a time constraints in term of signal computing and target identification. The design flow and the hardware implementation of each module are introduced in detail. The proposed system can operate up to 115 MHz by using full pipeline organization and parallel computing which increase the speed up of the target detection system to satisfy the real-time constraints. The proposed architecture is designed, implemented, and tested using Stratix II EP2S60F672C3N FPGA Board. The system has the advantages of being simple, fast, and flexible with low development cost for a reference window of length 16 cells. [C155]

"Twin target correction for ultra-wideband radar imaging of breast tumours"

Ultra-wideband radar imaging is a promising modality of imaging for breast cancer detection, based on the dielectric contrast between healthy and pathological tissues. Its aim is to create a map of microwave scattering, and has already proven encouraging results. Unfortunately, the tumor extraction procedure used for reconstruction of the scattering volume leads to the appearance of an artifact called twin target, where a single tumor is expected. In this paper, a signal processing technique is presented to remove this twin target and enhance the contrast of the final image. The radar system and image formation algorithm are first described to explain the origin of the twin target. Experimental data are then acquired and processed by our correction algorithm, demonstrating its ability to fix the twin target issue. [C156]

"A Bayesian perspective on sparse regularization for STAP post-processing"

Traditional Space Time Adaptive Processing (STAP) formulations cast the problem as a detection task which results in an optimal decision statistic for a single target in colored Gaussian noise. In the present work, inspired by recent theoretical and algorithmic advances in the field known as compressed sensing, we impose a Laplacian prior on the targets themselves which encourages sparsity in the resulting reconstruction of the angle/Doppler plane. By casting the problem in a Bayesian framework, it becomes readily apparent that sparse regularization can be applied as a post-processing step after the use of a traditional STAP algorithm for clutter estimation. Simulation results demonstrate that this approach allows closely spaced targets to be more easily distinguished. [C157]

"A Novel Detection Algorithm for Ultra Wide Band Short Range Radar in Automotive Applications"

Most significant part of radar target detection problems can be solved by using the method of statistical detection theory. Here the objective of the proposed optimal detection algorithm is to give a maximum detection probability for fixed false alarm probability. It is assumed that target is stationary and energy reflected from the target is distributed. The proposed detection algorithm has a squared sliding window in order to combine the reflected signals from the target. As the energy reflected from the target is more distributed, the proposed detector is superior to conventional non-coherent detector. The detection is based on one transmitted pulse against a background of white Gaussian noise (WGN). The performance of the proposed detector is analyzed and simulation has been done in order to verify. [C158]

"The Dedicated Short-Range Vehicle Tracking"

This paper describes the tracking of a vehicle by using a 3-dimensional positioning system, which is composed of two 2-dimensional Infrared (IR) signal source trackers. Once the 2D trackers detect the incident angles of the IR signal source, the 3D positioning system will locate the IR signal source. In the experiments, the detection on

the longitudinal direction is concerned, and the IR signal source on the preceding vehicle is detected by the 3D positioning system implemented on the following vehicle. While GPS cannot tell two adjacent vehicles, the short-ranged positioning system is able to locate the nearby moving target. [C159]

"Performance Analysis of OSAP-CFAR Detector in K Distribution Background"

The OSAP-CFAR employs soft rule based on fuzzy logic to give better detection probability than that of OSGO and OSSO-CFAR detectors for Weibull clutter. However, studies show that the K distribution provides a better fit for many clutter situations. The performance of the OSAP -CFAR is studied and compared with OSGO and OSSO-CFAR for the Swerling II target model in K distributed clutter. The results represent that the detection performance of OSAP-CFAR detector is superior to that of OSGO and OSSO-CFAR detectors both in the homogenous background and in multiple interfering targets situations. [C160]

"Experimental radar with 64-channel digital antenna array"

In this article are analyzed a results of experimental radar with digital antenna array full-scale test against above-water targets. [C161]

"Analysis of induced surface currents on high velocity target using a relativistic approach"

Radar is an electromagnetic system used for the detection and location of objects based on reflection. It operates by radiating energy into space and detecting the echo signal reflected from an object or target. This work analyzes how currents are induced on targets by the electromagnetic waveforms radiated by an antenna when the object is moving at high velocity. It is assumed that the target is a perfect electric conductor moving at high velocity. This work analyzes how the amplitude, the frequency and the duration of these currents are affected by the target velocity. The transmitted electromagnetic waveforms can then be calculated using vector potentials and by using the Lorentz transformation, the electromagnetic waveform is transformed from the stationary reference frame to a moving reference frame. Currents induced on the object can be modeled by using the transformed waveform and the equivalence principle. The object radiates an electromagnetic waveform as a consequence of the induced currents. The radiated waveform is calculated using the vector potentials and once more the reflected waveform is transformed from the moving reference frame to the stationary reference frame using the Lorentz transformation. Finally the equivalence principle was used to calculate currents induced in the antenna by the reflected electromagnetic waveforms. The relationship of the induced current on the antenna as a function of the target velocity is analyzed. [C162]

"Scattering of electromagnetic radiation for a perfect electric conducting cylinder by using multiple angles of polarization"

Radar is a device which detects distant or non visible objects by means of reflected radio waves. The quality of the reflected signal depends on the shape and orientation of the target with respect to the type of polarization used. Most of the antennas currently used on radar systems employ one type of polarization at a time for target detection. This paper describes the importance of employing polarizations of multiple angles on targets, approximately at the same instant of time. To implement this idea a generalized set of equations have been derived which represent the backscatter generated by a cylindrical object. Using different angles in these equations would give the backscatters of different polarizations employed on the same target, at small time intervals. The logic behind this is that there would be at least one angle that would have the maximum signal strength in the backscatter. The backscatter for this angle would satisfy the best quality criterion as compared with the rest of the polarization angles. [C163]

"Initialization of ballistic targets tracking filters with detection probability lower than unity"

Radar tracking of a projectile flying in the Earth's atmosphere is a very complex issue to cope with, due to the need of (suboptimal) nonlinear filtering techniques. Almost all cases found in literature assume that the target trajectory is observable from the firing point to the impact point on the ground, namely the trajectory observation gets under way from the first available measurement. The radar track initiation time is actually a stochastic quantity that has to be treated by means of a statistical procedure. In this paper a preliminary analysis of the effect of a more realistic filter initialization is proposed. [C164]

"Multitarget track before detect with MIMO radars"

Recent advances in Multiple-Input-Multiple-Output (MIMO) radar systems show that they have the potential to improve detection and localization performance of targets over bistatic and multistatic radars. Unlike beam forming, which presumes a high correlation between signals either transmitted or received by an array, the

MIMO system exploits the independence between signals at the array elements due to transmit diversity. Previous works focus on waveform design, signal processing and target localization with MIMO radars while no attention has been given to tracking algorithms. In this work, the problem of tracking multiple targets using MIMO radars is considered. The scenario includes multiple targets in a widely-separated MIMO architecture in which Radar-Cross-Section (RCS) diversity can be utilized. Multi target version of Track-Before-Detect (TBD) algorithm is implemented for the collected M ГґB— N orthogonal signals at the receiver, where M is the number of transmitters and N is the number of receivers. Besides having the advantage of integrating information over time on unthresholded measurements to yield detection and tracking simultaneously, the TBD technique enables tracking and detecting targets in low Signal-to-Noise-Ratio (SNR) environments. Also, a modified multiple sensor TBD, which weights the target observability to the sensor as a result of target RCS diversity in the likelihood calculation to best fit the centralized MIMO tracking is proposed. Finally, Monte Carlo simulations are performed to evaluate the performance of the proposed tracking algorithm. [C165]

"A track purity approach for tracking metrics"

Proper analysis of a simulated sensor tracking problem requires the ability to correctly determine the true trajectory that underlies each track. Traditionally, kinematic assignment of tracks to truth has been used. More recently, a "track-purity" approach has been proposed to both assess the performance of kinematic truth-to-track assignment algorithms and to overcome some of the anomalies that occur when kinematic assignment is used; particularly for unresolved closely-spaced targets. The track-purity approach relies on a simulation's unique ability to identify which truth objects contribute to each measurement. Less clear are the following issues: 1) When a measurement is formed, what is the percentage contribution from each truth object in each measurement primitive, 2) How should truth contributions be combined and modified as measurement data are passed through the various data and signal processing algorithms found in a typical monopulse phased-array radar (e.g., closely-spaced unresolved objects, direction-of-arrival estimation, measurement clustering, data assignment, filtering, and multi-sensor fusion), 3) How should truth content values be used to produce a content-based association between tracks and truth? The complete process for establishing the truth content of a track from the initial truth content of each detection to the final truth content at the output of track filtering is discussed. This discussion includes the effects of measurement clustering and centroiding, ambiguity in the measurement-to-track assignment, filter gains used to update the track's state estimate, and a truth-contribution-based method for establishing track-to-truth assignment. [C166]

"Tracking multiple unresolved targets using MIMO radars"

Multiple Input Multiple Output (MIMO) radars are a new generation of radar systems that may bring about many benefits compared to traditional phased-array and multistatic radars. Although different aspects of MIMO radars have been discussed in the literature, the application of MIMO radars in target tracking problems has not been explored in depth. Target localization using MIMO radars with co-located antennas has been discussed in the literature. The main limitation of those approaches is that the number of targets that can be uniquely localized in one cell is restricted. This paper presents a new application of MIMO radars in Multi-Target Tracking (MTT) problems. The main contribution is to show that the use of prior information about the motion of targets relaxes the limitation on the number of targets that can be uniquely detected. A general MTT problem with several targets in the same resolution cell is considered. The goal is to propose a technique to estimate targets' states and the number of targets in one cell. Because multiple targets may fall in the same cell, the measurement in a cell is associated with more than one target. Measurements are outputs of matched filters and range bins that are nonlinear functions of targets' states. Multiple hypotheses are generated based on the uncertainty in target-to-cell association. Then, the best model which gives the number of new targets whose estimates are obtained by the localization algorithm, is selected according to its likelihood . Finally, due to the nonlinearity in measurement model, a UKF based method is used to update estimates of new targets and initialize new born targets. Simulation results show the superiority of the proposed method for joint localization and tracking compared to the previous localization approach suggested in the literature for unresolved targets. [C167]

"Imaging method: A strong tool for moving target tracking by a multistatic UWB radar system"

In this paper, imaging method for moving target tracking by a multistatic ultra-wideband radar system is described. The task of moving target tracking consists in estimation of a target trajectory based on processing of raw radar data obtained from all receiving channels of a radar system. Then, the imaging method applied for target tracking consists of such signal processing phases as raw radar data pre-processing, background subtraction, fusion of the data obtained by receiving antennas of a radar, detection, localization and tracking itself. The performance of the imaging method described in this paper is demonstrated by signal processing obtained by M-sequence UWB radar for a scenario represented by through wall tracking of a single moving target. The obtained results confirm the excellent performance of the discussed method. [C168]

"An Algorithm of Weak Signal's Detection on the Condition of Strong Interfernce"

An algorithm which can detect weak signals on the condition of strong correlated interference is designed in the paper. The algorithm based on conventional beam forming (CBF) can put nulls on given directions. And the weights only relating to interference's direction is given in the paper. Comparing to adaptive methods, the algorithm is robust and the calculation account is smaller. Simulation results show the algorithm can put null on the strong interference's direction, getting a clear bearing track recorder while the CBF even can't get the target's track. [C169]

"A New Detection Method for MIMO Radar Using Hidden Markov Model"

MIMO radar is a new radar technique developed recently. It can achieve better detection performance than conventional phased radar. Based on the scattering statistic of clutter and man-made target, we propose that hidden Markov models (HMM) can be used to model the clutter and target signals, and that the HMMs can be used to detect target. Simulation results verify its efficiency. [C170]

"A GLRT detector in partially correlated texture based compound-Gaussian clutter"

This paper addresses the problem of target detection in the presence of a non-Gaussian clutter modeled in compound-Gaussian form which realizes the clutter process as a product of two independent random processes `texture' and `speckle'. The likelihood ratio test (LRT) detector applied to this detection problem reduces the detector to a matched filter (MF) when the texture is considered as completely correlated during a coherent processing interval (CPI). However, in practical applications, the textural component exhibits a correlation which is less than unity. The conventional form of MF based detectors existing in the literature yield a significant fall in the detection performance in such clutter scenarios. In this paper, we propose a generalized likelihood ratio test (GLRT) detector which can effectively detect a fluctuating target in the presence of a compound-Gaussian clutter with partially correlated texture. The results are presented to show the performance superiority of the proposed detector over the existing MF detector in such varying texture scenarios. [C171]

"Hybrid array for the detection and imaging of termites"

This paper describes a 24 GHz radar receiver array, designed to detect and image termite activity, behind a wall, floor or ceiling. This hybrid array is composed of two sub-arrays. A Direction of Arrival (DOA) sub-array for wide area detection of termites, and a 3D high resolution imaging sub-array for imaging individual termites. Here, we introduce an enhanced DOA algorithm, to resolve arbitrary numbers of targets, and compare simulation results with video of actual termites. [C172]

"Clutter suppression scheme for vehicle radar"

Vehicle radar receives echoes from the natural environment such as road and building. These echoes are called clutter which can be much higher than vehicle echo. It is therefore expect to improve the detection performance by summing all the radar echoes available from the vehicle. However, heavy road clutter should not be suppressed less than the vehicle echo by conventional integration schemes such as pulse integration and CFAR (Constant False Alarm Rate). Also the radar echo should include multiple vehicle targets as well as the clutter. Therefore it is not easy to detect multiple vehicle targets from heavy road clutter. In this paper, multiple targets detection with new clutter suppression scheme is discussed and the usefulness is investigated by conducting the measurement. As a result, the suggested scheme is found to suppress the heavy clutter significantly. [C173]

"Effects of I/Q mismatch on measurement of periodic movement using a Doppler radar sensor"

In this paper, the effect of I/Q mismatch in a 5.8 GHz direct-conversion quadrature Doppler radar sensor detecting periodic movement is studied. The measured movement amplitude under specific I/Q amplitude or phase mismatch is affected by the residual phase, which is determined by the nominal distance from the target to the antenna. It was found that there exist optimal residual phases minimizing the degradation of detection accuracy caused by amplitude and phase mismatches. Experiments were conducted to verify the theory. [C174]

"Space-based passive radar enabled by the new generation of geostationary broadcast satellites"

In this paper we investigate the possibility to develop a passive radar system for mid-range air target surveillance using, as illuminator of opportunity, a high EIRP level geostationary broadcast transmitter. These satellites are being introduced recently for Satellite Mobile Digital TV broadcast purpose. Since they are designed to allow mobile users to receive satellite TV without large antennas, a sufficiently high signal power is being transmitted, making them suitable as illuminators of opportunity in a passive radar system. The possibility to

resort to a quasi-stationary transmitter is shown to highly simplify the signal processing required by the passive radar system. A preliminary evaluation of the achievable SNR is conducted, showing that mid-range target detection can be achieved with reliable performance. In addition, a detailed analysis of the Doppler frequency contributions is conducted. Specifically, the Doppler frequency contribution due to the motion between target and transmitter is shown to be locally independent over the target position. The overall bistatic Doppler frequency behavior is evaluated for several possible target trajectories and some critical trajectories are identified. Finally, some remarks referred to the 2D Cross Correlation Function (2D-CCF) evaluation are reported. [C175]

"Transmit policies for MIMO radar detection and time-delay estimation"

This paper is aimed at investigating the role of Space-Time Coding (STC) for target detection and time-delay estimation through MIMO radars with widely spaced antennas. To this end we formulate the waveform optimization problem as a constrained maximization of some detection-oriented figures of merit under an accuracy constraint. Interestingly, such an additional constraint deeply modifies the optimal transmit policy. We also offer closed-form formulas of the Fisher Information in target delay estimation as a function of the singular values of the code matrix. Numerical results validating the theoretical findings are also given. [C176]

"Sparse representations for automatic target classification in SAR images"

We propose a sparse representation approach for classifying different targets in Synthetic Aperture Radar (SAR) images. Unlike the other feature based approaches, the proposed method does not require explicit pose estimation or any preprocessing. The dictionary used in this setup is the collection of the normalized training vectors itself. Computing a sparse representation for the test data using this dictionary corresponds to finding a locally linear approximation with respect to the underlying class manifold. SAR images obtained from the Moving and Stationary Target Acquisition and Recognition (MSTAR) public database were used in the classification setup. Results show that the performance of the algorithm is superior to using a support vector machines based approach with similar assumptions. Significant complexity reduction is obtained by reducing the dimensions of the data using random projections for only a small loss in performance. [C177]

"Time resources allocation in cognitive radar system"

This paper considers the problem of simultaneously detecting and tracking multiple targets. The main problem discussed here is the time allocation of cognitive radars in a multitarget environment. Radars are used to detect, to locate and to identify target. The radar performs three main functions: search, tracing and weapon engagement. Each of functions occupies amount of time. It is a key point that to allocate radar time ressource effectively. For cognitive radar, it should have the basic function which is learning. The radar needs to manage its resources dynamically and interactively between the setting of radar parameters to optimize the tasks the setting of radar parameters to optimize the tasks to be carried out and perceive environment highlights the role in which knowledge and intelligence will be central in cognitive radar performance. In this paper, we develop the optimization criterion based on the detection probabilities. [C178]

"MIMO radar target detection with parametric scattering correlation model"

Multiple-input multiple-output (MIMO) radars utilize various sources of diversity to improve the performance of the radar. A MIMO radar in which angular diversity is achieved by using widely distributed antennas has been proposed to reduce the impact of the fluctuations of the target radar cross-section. This type of system is also known as the statistical MIMO radar. Typically, it has been assumed that the signals received by different antennas are either fully correlated or independent depending on the configuration. In this paper, we assume more realistically that the scattering from the target is correlated. We show that taking the correlation of the scattered signals into account can improve the probability of detecting the target. This is achieved by using a parametric model for the scattering which allows one to efficiently estimate the scattering covariance matrix. The numerical examples demonstrate that the probability of detection remains good even when parameters of the model are inaccurate. [C179]

"Some Analysis of Fuzzy CAGO/SO CFAR Detector in Non-Gaussian Background"

In order to improve radar's detection performance under non-Gaussian background clutter. We design a new distributed fuzzy CAGO/SO-CFAR detection system including two sensors. Both sensors compute the value of the membership function mapping to the false alarm space according to the samples of the reference cells, in the fusion centre two values are combined according to four kinds of fusion rule to estimate the background clutter power. The simulation results prove the detection improvement of CASO based on algebraic-sum rule under multi-target environment, and present better false-alarm-control capacity of CAGO based on MIN rule under clutter-edge environment. [C180]

"Feasibility of range estimation using sonar LPI"

Using a detailed waveform-based simulation framework, a study on the feasibility of LPI sonar is performed for covert range estimation. A frequency selective channel filter is applied for realistic ocean simulation. The platform uses matched filtering and the target uses energy detection for processing the received signal. The objective of the platform is to estimate the range to the target while ensuring that the target still fails to detect the platform's pinging LPI waveform. A platform-target encounter scenario was designed for Monte Carlo simulation. Evaluation of system parameters was performed to assess for the feasible conditions for covert range estimation. [C181]

"Low electromagnetic coupling bistatic subsurface radar using EBG structures"

EBG structures have been developed widely for reducing electromagnetic coupling. On the other hand, Bistatic radar is a system which comprises a transmitter antenna and receiver antenna. In recent years, the bistatic subsurface radar is applied to detect relatively shallow structure such as tumor detection, steel reinforced detection in concrete and etc... On the other hand, the electromagnetic coupling between transmitter antenna and receiver antenna becomes problem, because, the bistatic radar detects a reflection wave from the target by the receiver antenna, therefore artifact caused by the coupling. To reduce this coupling a cavity is used, however, the cavity is not enough to reduce the electromagnetic coupling between transmitter antenna and receiver antenna. We have proposed bistatic radar system using EBG structure. In this paper, the bistatic radar system using EBG structures will be introduced briefly. And, the target detection result by using proposed bistatic radar system will be indicated. [C182]

"A novel signal processing method for MIMO radar based on channel estimation"

Multiple Input Multiple Output (MIMO) radar is a new radar technique. It has many advantages over conventional phased radar in many ways such as anti-intercept of radar signal, low velocity target detection, and resolution. The signal transmit matrix of MIMO radar has much information such as target angle. In this paper, we analyze the signal model for MIMO radar. And then we present a new method to estimate the target angle from the matrix. At last, we show the efficiency by some simulations. [C183]

"STS-128 on-orbit demonstration of the TriDAR targetless rendezvous and docking sensor"

Neptec has developed a vision system for autonomous rendezvous and docking in space that does not require the use of cooperative markers, such as retroreflectors, on the target spacecraft. The system uses an active TriDAR 3D sensor along with embedded model based tracking algorithms to provide, out of the box, 6 degree of freedom (6DOF) relative pose information in real-time. The TriDAR (triangulation + LIDAR) sensing technology combines active triangulation and Time-of-Flight (TOF) ranging techniques within a single optical path. This design takes advantage of the complementary nature of these two technologies to provide optimal 3 dimensional data from several kilometers all the way to docking. A thermal imager is also included to provide bearing information at long range. In partnership with the Canadian Space Agency (CSA) and NASA, Neptec has space qualified the TriDAR vision system and integrated it onboard the Space Shuttle Discovery to fly as a Detailed Test Objective (DTO) on the STS-128 mission. The objective of the TriDAR DTO mission was to demonstrate the system's ability to perform acquisition and tracking of a known target in space autonomously and provide real-time relative navigation cues. Autonomous operations involve automatic acquisition of the ISS, real-time tracking as well as detection and recovery from system malfunctions and/or loss of tracking. This paper presents an overview of the TriDAR system as well as results from on-orbit testing of the TriDAR during the STS-128 Space Shuttle mission. [C184]

"New detection manifolds for radar signal processing"

This paper examines direct data domain (DDD) moving target detection for multi-channel space-based radar (SBR). DDD techniques differ from data-adaptive processing methods in that they do not rely on statistically stationary and homogeneous training data in order to estimate and null out clutter or interference and thereby reveal potential targets; instead, they operate on each range-Doppler cell independently, after any necessary preprocessing to compensate for platform motion and/or array calibration. Prior work examined a maximum-likelihood angle-of-arrival (AOA) technique and the associated target power estimator to detect slow moving targets. In this paper, we extend that methodology and propose novel detection manifolds for optimally partitioning the two-dimensional statistical space. The two dimensions are formed by the passive AOA likelihood function and the estimated target power. A computer simulation of a space radar system and associated geometry is used to assess the characteristics and performance of the new concept. We show that the two-dimensional probability densities corresponding to the target absent and target present hypotheses (H0 and H1, respectively) occupy regions in this space that are not optimally separated by independent thresholds. This

immediately leads to the novel detection manifolds (or curved boundaries between detections and non-detections) that improve the detection probability while also reducing the false alarm rate. [C185]

"Coupling optimal method of segmentation with restoration for target detection in SAR images"

High-quality segmentation is there in a need in SAR images for appropriate target detection. In this paper, the features of Wiener filter are utilized with region of interest and Boundary based segmentation technique in SAR images. The discrete Wiener filter exhibits both linear and nonlinear characteristics. This filter compensates for the blurring due to the linear term and conserves the edges which are mainly used to distinguish the various objects with the gross representation of object of interest. The filter is defined both for edge preserving along with speckle noise cancellation in SAR images. A combination of features from two different types of multi-resolution and multi-channel filters, in general provides superior classification of SAR images. The experimental results show that the proposed boundary based and ROI technique segments the SAR image while the opted filter preserves significant features and noise removal. The fusion performance is evaluated on the basis of Mean square error, time, and signal-to-noise ratio. [C186]

"New Technology and Applications on Millimeter-Wave Sensors"

Some new technology and applications on millimeter-wave sensors are reviewed. A novel method of human presence detection using passive millimeter-wave (MMW) sensors is presented. The method focuses on detecting a standing human from a moving platform in a cluttered outdoor environment using MMW radiometry. Millimeter-wave stepped-frequency sensor and millimeter-wave interferometric sensor are completely realized using microwave integrated circuits (MICs) and microwave monolithic integrated circuits (MMICs). The millimeter-wave stepped-frequency sensor operates from 29.72 to 37.7GHz and has demonstrated abilities in surface and near-surface sensing, including profile mapping, liquid-level monitoring, and anti-personnel mine locating. The millimeter-wave interferometric sensor operates at 35.6GHz and has demonstrated its multi-functional capability for measurement of displacement and low velocity. A new radar sensor architecture comprising an array of transceiver modules. Target applications of the sensor are automotive driver assistance systems. Experimental results with an eight channel radar sensor in the 76-77GHz frequency band are presented, which demonstrate the feasibility of the proposed architecture and show the performance of the modulation sequence and signal processing. Finally the technical challenges of millimeter-wave sensor systems are discussed. [C187]

"Aircraft discrimination in high resolution SAR images based on texture analysis"

Target discrimination is the key step of automatic target detection in synthetic aperture radar (SAR) images. Aiming at the issue of aircraft discrimination in high resolution SAR images, a novel discrimination method is proposed with using texture features. First of all the method of gray level co-occurrence matrix is used to generate eight discrimination texture features: mean, variance, deficit moment, inertia moment, entropy, angular second moment, relevance and non-similarity and then forming a feature vector. Differing with the common method of extracting the holistic texture features of image to represent the target, the texture features of each pixel are extracted and the feature vectors of all pixels are used to represent the target. Then J-M distance is used to measure the different targets, and supervised training method is applied to achieve the parameters of discrimination rule. Finally, suspected targets are discriminated to different classes by the trained discrimination rule and large numbers of false alarms are eliminated efficiently. The experiments show that the aircraft has small distance to other aircrafts while large difference to false alarms, so this discrimination method has high accuracy with excellent applicability. [C188]

"Wavelet analysis of impulse ultra-wideband radar"

In this paper, we have enhanced ultra-wideband (UWB) radar signal-to-noise ratio (SNR) by applying a wavelet transform (WT) based matched filter. The wavelet transform algorithm (WTA) provided enhanced reliability relative to conventional background template subtraction (BTS) approach, increasing reliability detecting targets in the nonlinear close in (<50 cm) and at the maximum distance tested (29 m.) We extrapolated the WTA can support a maximum radar range of 60 m, about twice that available with the conventional constant false alarm rate (CFAR) methods. [C189]

"Analysis of sea clutter distribution variation with Doppler using the compound k-distribution"

Sea clutter is the backscattered returns received by a radar system from the sea surface. Maritime radar signal processing has the ability to partially compensate for clutter to achieve effective detection of targets on or near the sea surface. This paper investigates the fit of the compound k-distribution model to sea clutter amplitude statistics, within individual Doppler bins across the Doppler spectra. The data used was recorded with a monostatic coherent X-band radar on an airborne platform; both horizontally and vertically polarized data has

been analysed. The statistics of the sea clutter distributions have been evaluated using the probabilities of false alarm (PFA), which are the calculated from the sea clutter cumulative amplitude distributions. These curves are plotted as a function of detection threshold. K-distributions have been fitted to the PFAof the sea clutter across the Doppler spectrum. The variation of the fitted shape parameter with Doppler bin has been used to identify the relationship between backscattered sea clutter and Doppler. The results show a clear variation with Doppler of the shape parameter obtained from the fitted distribution. The variation is also found to change with polarisation. [C190]

"Characterization of Doppler effects in the context of over-the-horizon radar"

This paper addresses the problem of the characterization of Doppler effect of maneuvering targets in the context of over-the-horizon radar. The received signal has a complex Doppler structure which is composed of several arrivals, each corresponding to a particular path. In essence, it consists of several close time-frequency components with non-linear signatures in the time-frequency domain. The nonlinearities are the projections of the target's motion vectors on the propagation paths. Estimating the time-frequency contents of all paths reveals the Doppler effects characterizing the target's trajectory. Analysis of such signals in the presence of strong clutter requires effective non-stationary signal processing techniques. In this paper, we propose a new technique based on local analysis of the phase information using warped high-order ambiguity function. The results depict resolvable multipath estimates which are very close to the ground truth. [C191]

"Ultra-wideband forward scatter radar fence for maritime surveillance-Initial experimental results"

The work described in this paper is a continuation of previous analytical work that has progressed to an experimental phase. The paper discusses the development of an ultra-wideband (UWB), forward-scatter radar (FSR) system for the detection and (ultimately) automatic recognition of low reflectivity maritime targets. Here we present the concept, developed hardware and selected initial experimental results. A number of novel ideas have been developed to reduce cost, size, prime power requirement, complexity and utilise the advantages of FSR operation. System benefits include increased target cross section (over conventional bi/monostatic radar), increased target detection capability, robustness to stealth targets, decrease in sea clutter effects from synthesis of extremely narrow beams whilst using omni directional antennas and sub-Hertz Doppler frequency measurement capability. The experimental work investigates the use of an UWB FSR fence for security, UWB propagation measurements, UWB sea clutter measurements at very low grazing angles, UWB spectral coverage and the synthesis of narrow beamwidth antennas using forward scatter pulse transmission. [C192]

"Comparison of PHD based filters for the tracking of 3D aerial and naval scenarios"

The Probability Hypothesis Density (PHD) filter is applied to realistic three-dimensional aerial and naval scenarios to illustrate its performance in detecting, initiating and terminating tracks in presence of clutter. Radar measurements are available every two seconds. A comparisons between different approximations of the PHD recursion, namely the sequential Monte Carlo and the Gaussian Mixture approximation, is given on different scenarios using the OSPA metric and different levels of clutter. [C193]

"Automatic recognition of multiple targets with varying velocities using quadratic correlation filters and Kalman filters"

Automatic target recognition (ATR) systems require detection, recognition, and tracking algorithms. The classical approach is to treat these three stages separately. In this paper, we investigate a correlation filter (CF)-based approach that combines these tasks for enhanced ATR. We present a Kalman filter framework to combine information from successive correlation outputs in a probabilistic way. Our contribution is a framework that is able to locate multiple targets with different velocities at unknown positions providing enhanced ATR with only a marginal increase in computation over other CF ATR algorithms. [C194]

"Signal modelling for ground moving target in complex image domain of multi-channel SAR"

For along-track multi-channel synthetic aperture radar (SAR), this paper proposes a novel ground moving target signal model in the high-resolution complex image domain. It is shown that moving targets can be divided into three types according to the 2D motion distribution and the SPP approximation conditions. Moreover, a single target can be split into two targets in the image. All types of targets will have the same Doppler interferometric effect along multichannel images, which is decided by the target's ambiguous Doppler frequency. Furthermore, with our derived signal model, the complex image properties, i.e., amplitude reduction, azimuth shift, azimuth defocus, range blur, 2D slant, second-order phase modulation, split, interferometry and the effects of 2D accelerations are analyzed for airborne and spaceborne SAR, respectively. Finally, some experimental results are also provided to demonstrate the effectiveness of the proposed signal model and analysis. [C195]

"Spatially-varying calibration of along-track monopulse synthetic aperture radar imagery for ground moving target indication and tracking"

In this research, we have developed an algorithm to reduce the residual artifacts of the background clutter (that is, stationary targets) that appear in the MTI imagery that are generated by Global Signal Subspace Difference (GSSD) of the monostatic and bistatic images of an along-track monopulse synthetic aperture radar (SAR) data. We have also established the theoretical foundation for estimating the motion track and parameters of the detected moving targets. We will show the results of these algorithms on measured SAR data. [C196]

"The effect of clutter on the automatic target classification accuracy in FSR"

The clutter influence on the automatic target classification (ATC) accuracy in forward scattering radar (FSR) is presented. To study the ATC at various signal-to-clutter ratios (SCR), a simulated vegetation clutter is artificially added to the real clutter-free targets recorded signals. It is shown that using conventional clutter-uncompensated ATC system can achieve high target classification accuracy at high SCR only, but the accuracy drops significantly with SCR decreasing. The employment of clutter-compensated ATC system is shown to improve significantly the classification accuracy at low SCR. [C197]

"Design considerations for a modern naval fire control radar"

This document describes some design considerations for a modern naval fire control and tracking radar. The main purpose of this type of system is to track one, or sometimes a few, targets extremely accurately. Some of the basic design considerations have not changed considerably over the years, even if the solution is different due to e.g. increased processor capacity. This paper will briefly outline some of these basic considerations but will concentrate on the areas where new considerations affect the design. [C198]

"Analysis of multi-sensor radar detection based on the TBD-HT approach in ECM environment"

This paper describes in details the performance of an advanced detecting algorithm for multi-sensor target Track Before Detection (TBD) through the Hough Transform (HT). The detection algorithm employs the idea of using the Hough Transform for joint detection of linear trajectory targets. The polar modification of the TBD-HT approach is applied to a multi-sensor Polar Hough detector for multi-sensor target/trajectory detection in ECM environment with a Stand-off-Jammer (SOJ). A CFAR detector is proposed for signal detection in the (r-t) space instead of fixed thresholding in order to enhance the target detectability in ECM environment. In this paper a centralized structure of a multi-sensor Polar Hough detector is considered. The expressions calculating the probability characteristics, i.e. the probability of target/trajectory detection and the false alarm probability, are analytically derived. The multi-channel TBD-HT detector probability characteristics are compared with those for the conventional signal processing. [C199]

"A region-growing based clustering approach for extended object tracking"

In the case a scenery consisting of multiple moving objects has to be observed and analyzed by using radar, it may occur that extended objects cause more than one observation. As a consequence, a conventional tracking algorithm, that bases on the assumption of point objects, has to process lots of observations, generates several tracks per object and thus is slowed down distinctly. Moreover, it is necessary to sort out and merge the tracks before they can be used. In order to avoid these problems, a clustering algorithm for radar-based object tracking is presented in this paper. The algorithm combines, assigns and discards observations before they are passed on to the tracking. Thereby not only the observations are utilized, but also the existing tracks. Furthermore, the method proposed and its benefits are tested in the example of an automotive object tracking system. [C200]

"MIMO radar sparse angle-Doppler imaging for ground moving target indication"

We present in this paper a regularized sparse signal recovery algorithm, referred to as sparse learning via iterative minimization (SLIM), to provide ground moving target indication (GMTI) through multiple-input multiple-output (MIMO) radar angle-Doppler imaging. A slow-time modulation scheme with code division multiplexing is employed to achieve transmit diversity. In this way, we avoid the high correlation properties of orthogonal waveforms and the Doppler ambiguity that is encountered with Doppler division multiplexing schemes. After removing jammer and clutter effects using semi-unitary projections, we show that SLIM, using primary data only, is able to form sparse angle-Doppler images and to provide for accurate target localization. [C201]

"Robust short-range clutter suppression algorithm for forward looking airborne radar"

The short-range clutter has serious range dependence for forward looking airborne radar (FLAR). As a result, when a radar detects moving targets on far range gates, the ambiguous short-range clutter degrades the performance of ground moving target indication (GMTI) obtained by space-time adaptive processing (STAP). The elevation three dimensional adaptive processing can well mitigate the problem, but, the computational load of the method is too heavy to be applied in real scenarios. A robust elevation pre-filtering algorithm is proposed. This method does not need adaptive processing on the elevation elements in a planar-array antenna. Therefore, the computational load can be reduced greatly. This method suppresses the ambiguous short-range clutter by multi-elevation angles restriction and the cancellation weight on the clutter has a deep and wide notch. Moreover, the method is robust to the elevation angle errors. Simulation results show the validity of the method. [C202]

"UWB radar and leaky waveguide for fall on track object identification"

This paper presents a new system for detecting and identifying objects fallen onto railway tracks. The proposed solution is based on an ultra-wideband (UWB) radar technique combined with a slotted waveguide transmission line. A rectangular section, slotted waveguide is maintained all along the railway platform and used as a succession of monostatic radars. A design procedure is described. A procedure of extraction of target's electromagnetic signatures is discussed; simulation results are produced. [C203]

"Long-time coherent integration for radar target detection base on Radon-Fourier transform"

Based on the internal coupling relationship among radial velocity, range-walk and Doppler frequency of moving target's echoes, this paper proposes a novel method, i.e., Radon-Fourier transform (RFT), to realize the long-time coherent integration for radar target detection. The RFT realizes the echoes spatial-temporal decoupling via joint searching along range and velocity directions, as well as the successive coherent integration via the Doppler filter bank. Besides, it is shown that RFT is a kind of generalized Doppler filter bank processing for targets with across range unit (ARU) range walk. Finally, numerical experiments are provided to demonstrate the effectiveness of the proposed methods. [C204]

"3D feature estimation for sparse, nonlinear bistatic SAR apertures"

We present an algorithm for extracting 3D canonical scattering features observed over sparse, bistatic SAR apertures. The input to the algorithm is a collection of noisy bistatic measurements which are, in general, collected over nonlinear flight paths. The output of the algorithm is a set of canonical scattering features that describe the 3D scene geometry. The algorithm employs a pragmatic approach to initializing feature estimates by first forming a 3D reflectivity reconstruction using sparsity-regularized least squares methods. Regions of high energy are detected in the reconstructions to obtain initial feature estimates. A single canonical feature, corresponding to a geometric shape primitive, is fit to each region via nonlinear optimization of fit error between the complex phase history data and parametric scattering models using a modification of the CLEAN method. Feature extraction results are presented for sparsely-sampled, nonlinear, 3D bistatic scattering prediction data of a simple scene. [C205]

"Clutter properties for STAP with smooth and faceted cylindrical conformal antennas"

Conformal antennas, which assume the shape of the platform, have several advantages; like reduced weight and space, aerodynamic design and increased field of view. We are interested in detection of moving ground targets with air-borne radar with faceted or smooth vertical half-cylinder or planar antennas with different subarray sizes. We simulate radar systems and study clutter properties which are important for suppressing the clutter with STAP (Space-Time Adaptive Processing), properties by which we can compare the antennas. We use old analysis tools and propose some new which are easy to interpret and draw conclusions from. We find that the faceted and smooth half-cylinder antennas have no significant differences in clutter suppression performance. The plane antenna has poorer performance. The subarray division is more important than the antenna geometry. The number of antenna channels is related to the clutter rank and the clutter fraction of the signal space. [C206]

"Two-step GLRT design of MIMO radar in compound-Gaussian clutter"

This paper mainly deals with the target detecting problem using a MIMO radar against compound-Gaussian clutter with an unknown covariance matrix. The space-time coding MIMO radar model has adopted, and developed to compound-Gaussian case. The detector based on generalized likelihood ratio test (GLRT) criterion is studied, and two-step design procedure is adopted. Specifically, the GLRT is derived by assuming known covariance matrix, and then, a suitable estimate based on secondary data is inserted into the derived detector to make fully adaptive. Some numerical results are given, showing that the derived GLRT can provide a good performance in spikier clutter and the adaptive loss is acceptable. [C207]

"MIMO radar detection and adaptive design in compound-Gaussian clutter"

Multiple-input multiple-output (MIMO) radars with widely separated transmitters and receivers are useful to discriminate a target from clutter using the spatial diversity of the scatterers in the illuminated scene. We consider the detection of targets in compound-Gaussian clutter. Compound-Gaussian clutter describes heavy-tailed distributions fitting high-resolution and/or low-grazing-angle radars in the presence of sea or foliage clutter. First, we introduce a data model using the inverse gamma distribution to represent the clutter texture. Then, we apply the parameter-expanded expectation-maximization (PX-EM) algorithm to estimate the clutter texture and speckle as well as the target parameters. We develop a statistical decision test using these estimates and approximate its statistical characteristics. Based on the approximation of the statistical characteristics of this test, we propose an algorithm to adaptively distribute the total transmitted energy among the transmitters. We demonstrate the advantages of MIMO and adaptive energy allocation using Monte Carlo simulations. [C208]

"Application of the CLEAN Detector to low signal to noise ratio targets"

This paper expands on the author's previous work by adapting the CLEAN algorithm to address low signal to noise (SNR) targets. The Reformulated CLEAN Detector is presented which is shown to allow the detection of low SNR targets in the presence of large targets. Performance results are presented that show how good performance can be attained by combining the correlator, CLEAN Deconvolver and Reformulated CLEAN Detector. [C209]

"Enhanced detection and characterization of human targets via non-linear phase modeling"

Many current radar-based human detection systems employ some type of Doppler or Fourier-based processing, followed by spectrogram and gait analysis to classify detected targets. However, Fourier-based techniques inherently assume a linear variation in target phase over the aperture, whereas human targets have a highly nonlinear phase history. This mismatch leads to significant loss in SNR and integration gain. In this paper, two novel human-modeling based non-linear phase detectors are presented. The first (ONLP) computes maximum likelihood estimates of unknown parameters of a model of the human torso response, while the second (EnONLP) stores the expected returns of a 12-point model for each combination of model parameter values in a dictionary and uses orthogonal matching pursuit to find the optimal sparse approximation to the data. The performance of ONLP, EnONLP, and conventional STAP is compared and application to target characterization discussed. [C210]

"Detection of dismounts using synthetic aperture radar"

This paper presents an approach to detect people, or dismounts, using synthetic aperture radar (SAR). This approach is compared qualitatively with ground moving target indication (GMTI) radar and then quantitative results are presented using a P-band single phase center SAR. It is demonstrated that SAR provides an excellent methodology to detect dismounts. [C211]

"A fast FRFT based detection algorithm of multiple moving targets in sea clutter"

On the basis of the detection and estimation model of multiple moving targets, a new algorithm based on wavelet packet transform (WPT) and fractional Fourier transform (FRFT) is proposed for weak moving targets detection in sea clutter. The multi-resolution property of WPT and the characteristic of good energy concentration on LFM signals in FRFT domain are combined together. At first, optimal wavelet tree is calculated using "minimum Shannon entropy" and threshold censored method is used to suppress sea clutter of different frequency bands. Then, take the absolute amplitude of signals after FRFT as test statistic and search for peaks in two dimensions with the threshold. Grading iterative method is used for parameter estimation with fast calculation speed and the shading problem between multiple targets is solved through "CLEAN" method. In the end, simulations with IPIX data indicate that the proposed algorithm has good performance of detecting low-observable moving targets in sea clutter. [C212]

"Detection of runway boundary in ATC ground radar"

The radar environment is usually nonstationary and an efficient adaptation requires real-time exploitation of a priori knowledge concerning the environment surrounding the radar. In an airport contest, the radar scenario is heavily influenced by the inevitable presence of interferences, the background clutter, but other interferences (presence of vehicles and unwanted signs on the runway) contribute to make difficult the target detection. In particular, the paper addresses the detection of the runway boundary in ATC (Air Traffic Control) ground radar signal which can be not well defined due to the grass growth in different period in the islands near the runways. The grass growth can cause critical situation because the signal level of the grass zones is equal to that of the

asphalt and it needs a visual analysis by a human operator to determine the presence of objects and targets in this clutter area. An active contour search algorithm (Snake algorithm) is used for detecting the runway boundary in SMR radar images. In our application a standard Snake algorithm is adapted and it is possible to obtain a reasonable approximation of the actual contour, which greatly reduces drawbacks related to the presence of the local minima. The performance of the active contour algorithm is tested on a set of radar images extracted from SMR radar images acquired in Italian airports. [C213]

"Optimal transmitting diversity degree-of-freedom for statistical MIMO radar"

Statistical multiple-input multiple-output (MIMO) radar may improve the fluctuated target detection by utilizing the multiple separate transmitting and receiving elements. Nevertheless, the transmitting power of single element is reciprocal to the transmitting element number, and the ultimate detection performance of MIMO radar may be inversely deteriorated with the increase of the transmitting elements. In this letter, the optimal transmitting diversity DOF, i.e., the optimal separate transmitting elements, is defined based on the proposed likelihood ratio test (LRT) detectors. Furthermore, with the given false alarm probability and detection probability, the closed-form optimal DOF approximations are derived for the two sub-forms of statistical MIMO radar, i.e., distributed MIMO radar and multiple-input single-output (MISO) radar, respectively. It is shown that a small transmitting diversity DOF, as well as the small number of orthogonal transmitting waveforms, may be needed for optimizing the statistical MIMO radar spatial diversity performance. Finally, numerical experiments are also provided to demonstrate the effectiveness of the proposed methods. [C214]

"STAP analysis using multi-channel airborne radar data from flight trials"

Flight trials have been performed within the NORA program in order to acquire multi-channel clutter data for different types of terrain, terrain scattered interference, and SAR data. The acquisition of clutter and terrain scattered interference has been made in order to prepare a database for future development of operational space-time adaptive processing (STAP) algorithms applicable to active electrically scanned antenna (AESA) systems employing multiple sub-aperture configurations. In this paper we show some preliminary results that illuminate the benefit of using all four dimensions of multi-channel radar data in a clutter rejection perspective. To illustrate the behavior of multi-channel clutter we employ spatial spectrum estimation methods such as Fourier and MUSIC. We also demonstrate post-Doppler STAP results for the air-to-air case. The results are very promising and indicate that multi-channel processing will indeed enhance the ability to detect targets obscured by clutter. [C215]

"Adaptive polarization processing for improved detection/classification of stationary targets"

A new technique for detection of stationary or slow-moving over-resolved targets on the ground, based upon a Hotelling T-squared test/generalized inner product (GIP) approach to signal analysis is presented. This robust detector separates radar returns from interference via a coherent process. This GIP-based processing can be applied to single-receiver channel systems, multiple spatial channel systems, multiple polarization channel systems or systems with multiple spatial and polarization channels. [C216]

"Space and frequency diversity for moving personnel spectrogram estimation"

In this paper we investigate the application of frequency and space diversity as a mean for providing a better understanding of the features of a target. For this purpose space diversity is exploited for developing a way for processing the information gathered through multistatic measurements of moving targets. The aim is to decompose and rearrange the gathered information, which can be of interest when the radar network is comprised of a multitude of devices. Processing appropriately angle-diverse spectrograms can actually help recovering side-effects due to the movement of the target, such as shadowing of characteristic features. Although in this paper the targets are moving persons, the presented technique can be applied to any class of targets. In addition the effects of the variation of the carrier frequency are also investigated. This allows us to understand the potential of having an increased discrimination of the features and to compare the effects of the proposed technique. [C217]

"Multistatic radar imaging of moving targets"

We develop a linearized imaging theory that combines the spatial, temporal, and spectral aspects of scattered waves. We consider the case of fixed sensors and a general distribution of objects, each undergoing linear motion; thus the theory deals with imaging distributions in phase space. We derive a model for the data that is appropriate for narrowband waveforms in the case when the targets are moving slowly relative to the speed of light. From this model, we develop a phase-space imaging formula that can be interpreted in terms of filtered backprojection or matched filtering. For this imaging approach, we derive the corresponding phase-space point-

spread function. We show plots of the phase-space point-spread function for various geometries, and various combinations of waveforms. [C218]

"Moving target detection and characterization with circular SAR"

In this work, we examine ground target detection and characterization from radar data, which incorporates a modelbased optimization method called dynamic logic (DL). We apply our methodology to a prototype airborne radar platform called Gotcha, developed by the Air Force Research Laboratory/Sensors Directorate/Automatic Target Recognition Division in recent years. The aircraft traces out a circular path around an area of interest, and the onboard, side-looking radar transmits and receives energy at a constant pulse repetition frequency, while the main beam direction is maintained at a fixed aim point on the ground. Data collected during any appropriate length arc of the flight path can be used to create synthetic aperture radar (SAR) images of the ground. The data can also be used for ground moving target indication (GMTI) and provide Doppler/Range imagery of the same ground area. Our approach combines the computation of Range-Doppler surfaces and a variable target velocity backprojection SAR method. Potential targets are detected using multiple backprojection images and features are extracted using adaptive mixture models. We demonstrate the feasibility of our approach using target truth information provided with the Gotcha dataset. We outline the steps toward implementing a comprehensive automatic target tracking solution based on presented methodology. [C219]

"Performance prediction for a coherent X-band radar in a maritime environment with K-distributed sea clutter"

In this paper, theory is developed for the prediction of the false alarm (PFA) and detection (PD) performance of surface targets in K-distributed sea clutter detected by means of Doppler processing techniques. Vital to this analysis is the inclusion of the correlation properties of the sea clutter between all the pulses within a burst of pulses. The resultant technique allows for the prediction of PFAand PDfor each of the bins in the output of the Doppler processing stage of a fixed-threshold detector. The technique provides the ability to specify different thresholds for each of the Doppler bins. The analysis is extended to include Swerling type 1 and 2 targets for the calculation of PD. The performance of a noncoherent detector is provided for comparison. Results that demonstrate the application of the developed theory are also presented. [C220]

"Real-time tracking of bullet trajectory based on chirp transform in a multi-sensor multi-frequency radar"

Radar-based tracking technologies enable sub-time-of-flight bullet detection and trajectory tracking before the bullet reaches its target and thus lead to effective reduction of injuries and casualties. The capability of robust detection, tracking, and trajectory prediction in a weak signal environment directly translates to the awareness time for force protection. In this paper, we develop a multi-sensor multi-frequency radar platform and proposed the use of piecewise chirp transform for effective signal enhancement when the Doppler signatures are highly time-varying. Performed upon the time-frequency representations with improved phase information, multi-sensor multi-frequency radars uniquely localize and track bullets through unambiguous range and direction-of-arrival estimations. [C221]

"Pedestrian detection procedure integrated into an 24 GHz automotive radar"

Driving a car is a dangerous task! There are about 5000 fatalities on German streets every year, which is absolutely too much. Human beings have strong limitations in the ability to measure precisely the distance and the speed difference between cars which is the reason for several accidents. Therefore some individual assistance is needed. A radar sensor measures the target range and radial velocity very accurate and with high resolution even in multiple target situations and there is tremendous progress in 24 GHz radar sensor development. The objective of this paper is to protect vulnerable road users by a target recognition scheme. Therefore, a pedestrian detection procedure is additionally integrated into the 24 GHz automotive radar sensor. [C222]

"Double-step fast CFAR scheme for multiple target detection in high resolution SAR images"

A new double-step fast CFAR scheme is proposed for multiple target detection in SAR images. The conventional multiple-cell based CFAR (MC-CFAR) detector is performed to find a potential target area. MC-CFAR carries out a quick search by which the CFAR sliding window is shifted by several cells for the reduced computational loads and it can also effectively reduce the small sized false alarm in the vicinity of the test cell. For the final target decision, the single-cell based CFAR detection is only applied to the pre-processed potential target areas. Using real-SAR image, the proposed CFAR scheme is compared with the conventional method in the sense of

computational time and false alarm rate, which shows the faster computational speed and the lower false alarm rate. [C223]

"Stochastic system identification approach to radar data processing"

Space-time adaptive processing (STAP) algorithms typically consist of a data transformation step to reduce the number of degrees of freedom and a sampling step wherein radar returns from adjacent range bins are used to estimate interference statistics. The reduction in degrees of freedom, inadequate sample support, presence of target in sampled data, and range dependence of interference are some of the main reasons for STAP performance loss. In this paper, we present another approach to target detection and localization that mitigates these performance losses. The approach is based on the well-known stochastic realization algorithm from system identification theory. In this approach, we use the radar return data for a given range bin to identify a minimal stochastic state space model for the return data. The angle and Doppler for all targets in the range bin are computed from the state space matrices. All the computations involved use standard linear algebra. As interference statistics are not directly computed and since there is no sampling from adjacent range bins, the proposed approach is more robust to sample support, target in training and range dependence of clutter. A numerical comparison of the proposed approach with beam-space post-Doppler STAP using simulated data is given. [C224]

"Detection of complex point targets in a MIMO radar system with distributed assets and partially correlated signals"

A complex point target is a mathematical model for a radar target that is not resolved in space, but exhibits varying complex reflectivity across different bistatic view angles. The complex reflectivity can be modeled as a complex stochastic process whose index set is the set of all bistatic view angles, and the parameters of this stochastic process follow from an analysis of a target model comprising a number of ideal point scatterers randomly located within some radius of the targets center of mass. Six different models are summarized here, with different assumed distributions on the locations of the point scatterers within the target. We develop data models for the received signals from such targets in a MIMO radar systems with distributed assets and partially correlated signals, and consider the resulting detection problem. The problem reduces to the familiar Gauss-Gauss detection problem with hypoexponential test statistic. A related problem of adapting the transmitted signals to the target model is discussed. [C225]

"Phase-coded-linear-frequency-modulated waveform for low cost marine radar system"

This paper proposes a continuous waveform to realize low transmitted power in a Radar system. The proposed waveform utilizes a pulsed compression scheme based on phase-coded modulation and linear FM which combines the desirable properties of both types of modulation. This paper also verifies waveform operation under channel effects such as multipath and noise. We determine power optimization due to waveform compression gain for given system specifications and use correlation values to detect both unambiguous range and Doppler shift. With a pre-determined noise and Doppler threshold, we can distinguish targets from sea clutter. Finally, we show the improvement in accuracy of elevation measurements by simulation when auto-correlation instead of signal strength ratios are used to determine target height. [C226]

"Modified Capon and APES for spectral estimation of range migrating targets in wideband radar"

In many radar and sonar applications, the narrowband signal assumption is not respected. To preserve good performance detection and/or parameter estimation for wideband signal, it is necessary to develop appropriate signal models and processing algorithms. More specifically, the range migration of the target during the processing interval induces a coupling between range and Doppler that is not taken into account by standard algorithms such as the Capon and APES methods. In this paper, we present a modified and enhanced version of the Capon and APES algorithms for a wideband signal model. These two algorithms are adaptive filters designed for spectral estimation. Performance of the wideband-Capon and the wideband-APES algorithms are studied via numerical simulations. [C227]

"A robust Chinese remainder theorem with its applications in moving target Doppler estimation"

The Chinese remainder theorem (CRT) is an ancient result about simultaneous congruences in number theory, which reconstructs a large integer from its remainders modulo several moduli. It is well known that the CRT has tremendous applications in many fields, such as computing and cryptography, an important one of which could be radar signal processing and radar imaging. However, it is also well-known that CRT is not robust in the sense that a small error in any remainders may cause a larger error in the reconstruction result, which will lead to a non-robust estimation. In this paper, we introduce a robust reconstruction algorithm called robust CRT. We show

that, using this robust CRT algorithm, the reconstruction error is upper bounded by the maximal remainder error range named remainder error bound, if the remainder error bound is less than one quarter of the greatest common divisor (gcd) of all the moduli. Although CRT has existed for about 2500 years, this robustness is the first time in the literature. Then, we show how this robust CRT can be used into the field of radar detection and Doppler ambiguity resolution, especially for fast moving targets, and later, simulations are given to illustrate the effectiveness and validness of this robust CRT algorithm. [C228]

"A robust neural network based pulse radar detection for weak signals"

In this paper we develop a neural network capable of detecting targets with weak echoes in a pulse radar. This is possible as the network is designed as a pattern classifier (in contrast to earlier work) together with a suitable but simple pre-processing of the returns. We demonstrate through simulations that such a network exhibits better range resolution and noise tolerance when compared to previous work based on neural networks. In addition, we examine the Doppler tolerance and the overall robustness of the trained network. [C229]

"The probabilities of track initiation and loss using a sliding window for track acquisition"

An analytical model is provided which describes the tracking process that evolves from a sequence of detection opportunities. We assume a sliding window of length N, with M (M ≤ N) detections required for track acquisition, and L consecutive misses required for loss of track. We provide a recursive solution for the probabilities of acquisition, loss, and being in track, and then define the distributions of the times of acquisition, loss, and duration for each track and gap that can develop. There are no restrictions on M, N, L, or on a varying sequence of associated detection probabilities. Numerical results are provided for typical cases. [C230]

"Radar-on-a-chip (ROACH)"

We discuss a single chip millimeter wave direct-conversion transceiver fabricated using 65 nm Bulk CMOS technology to produce a low power, ultra low cost radar-on-a-chip (ROACH). The proposed ROACH system operates at carrier frequencies around 77 GHz, and is capable of detecting a 0.5 square meter target at several hundred meters. We present a novel technology based radar equation, called the ROACH Equation, which presents radar performance in terms of technology parameters. In addition, building on the precise relationship between differential phase noise and coherent integration duration, we establish optimal conditions for switching between coherent integration mode and incoherent integration modes. Numerical examples demonstrate that the proposed integration scheme effectively extends the maximum detection range of the single chip radar with associated benefit of reduced computational cost and hardware implementation complexity. [C231]

"HF radar performance analysis based on AIS ship information"

High-Frequency (HF) radars are operated in the 3-30 MHz frequency band. For oceanographic applications low transmit power HF radar systems have been developed, which use surface electromagnetic wave propagation along the salty ocean surface. The WERA HF radar system transmits a power of 30 watts but achieves detection ranges up to 200 km, which are far beyond the conventional microwave radar coverage. Hence the radar system can be used for coastal monitoring. Due to external noise, radio frequency interference, and sea clutter the radar detection capability is limited. Real measured radar data from the WERA system were recorded for a 12-hour period. The measured radar data were correlated with simultaneously available Automatic Identification System (AIS) information, which shows current ship position, speed, course and type. This paper presents statistical analysis of maximum detectable range and target reflectivity to estimate the radar performance in case of different cargo ship sizes. Based on the order-statistic constant false alarm rate (OS-CFAR) detection rule the potentially detectable target range and aspect angle of different ship categories were analyzed. [C232]

"Firm track loss due to M of N track initiation of a radially inbound target"

This paper examines the firm track loss incurred by a fixed frame time radar performing track initiation using search detections. Firm track loss is the additional beam energy needed to achieve a desired firm track probability on a radially inbound target compared to a stationary target at that same firm track range. Firm tracks are established using an M or more detections out of N observations criteria. The firm track loss in dB is nearly linear with the product of velocity and frame time divided by firm track range. It is also insensitive to probability of false alarm and target radar cross section fluctuation models. It can be represented by a simple quadratic equation. The loss can be included in a radar range calculation worksheet such as a Blake chart to predict firm track range. A linear relationship is found between the firm track range of a moving target and a stationary target. [C233]

"Cramйr-Rao lower bounds for monopulse calibration using clutter returns"

Successful geolocation of ground moving targets utilizing monopulse techniques requires accurate characterization of the array manifold (i.e. monopulse response to off-boresight targets) and antenna pointing information. Utilizing techniques similar, in spirit, to those applied in synthetic aperture radar (SAR) to estimate the Doppler centroid of an image, we develop techniques to accurately estimate azimuth monopulse slope and boresight shift of an airborne ground moving target indicator (GMTI) antenna utilizing clutter returns from normally scheduled CPIs that are also used for target detection and geolocation. A statistical signal model is developed for the clutter returns as observed through the monopulse channels. Cramer-Rao lower bounds (CRLB) are developed for monopulse slope and boresight shift and compared to CRLB developed with SAR centroiding techniques as summarized in the literature. Analytical and numerical CRLB results show potential gains of one to two orders of magnitude at moderate to high clutter to noise ratios for a sum-difference system. [C234]

"LORAMbis A bistatic VHF/UHF SAR experiment for FOPEN"

LORAMbis is the experimental part of a joint research program between Sweden and France. The objective is to evaluate the performance of low frequency bistatic SAR for clutter suppression in various applications, e.g. under-foliage target detection or mapping of urban scenes. The airborne bistatic SAR data are acquired using the VHF/UHF component of the ONERA SAR system SETHI and the VHF/UHF LORA system operated by FOI. The first data collection campaign was conducted in December 2009. Focused bistatic SAR images have been formed and indicate that the implemented synchronization method is sufficient. It is based on a GPS disciplined 10 MHz reference signal that is generated in both systems. [C235]

"Power-aware distributed target detection in wireless sensor networks with UWB-radar nodes"

Distributed detection of targets is one of the major applications of wireless sensor networks. Many existing results on distributed detection are either derived from analytical models or are based on simulations. In this paper, the performance of a distributed target detection system is evaluated by real measurement data obtained by UWB-radar-based sensor nodes. After local processing of the radar signal, the sensor nodes transmit their local decisions about the absence or presence of the target to a fusion center. For this purpose, a power-aware algorithm for resource allocation, which is tailored for UWB communication links is discussed. The feasibility and the effectiveness of this algorithm is evaluated by a hybrid approach based on the measurement data and simulations. [C236]

"Evaluation of modulus-constrained matched illumination waveforms for target identification"

In prior work, we have applied matched illumination strategies to target identification by a closed-loop radar system. In the closed-loop system, multiple waveforms are transmitted in succession, but each is customized based on the returns from prior transmissions. In this prior work, however, the matched waveforms were not constrained to be constant modulus. This current paper evaluates the performance of closed-loop radar with constant-modulus matched illumination. We also compare the performance of non-constant-modulus illumination under a peak power constraint. Finally, we use simple target models and assume unknown orientation, rather than the deterministic or Gaussian target models used in earlier work. [C237]

"Multipath Doppler signatures from targets moving behind walls"

Detection, localization, and tracking of moving targets are highly desirable in through-the-wall sensing applications. Since the indoor environment is rich in multipath reflective sources, such as walls, floor, and ceiling, the received signal is composed of the direct path and several multipath arrivals. However, on occasions, the direct path to the target may be blocked as the target traverses behind large metallic objects such as file cabinets, etc. In such cases, multipath is the only observable return and can be exploited to detect and maintain tracking of moving targets. In this paper, we provide range-Doppler analysis of multipath arrivals for a diffuse target moving in an enclosed urban structure, which provides insight for the development of through-the-wall detection and tracking techniques based on multipath exploitation. [C238]

"Ambiguity Function analysis of WiMAX transmissions for passive radar"

In this paper the feasibility of a WiMAX transmissions based Passive Bistatic Radar (PBR) is analysed. The Ambiguity Function (AF) of the considered waveform of opportunity is characterized with reference to different transmission modes. The signal AF is shown to yield regularly spaced undesired peaks which might strongly limit the target detection capability of a WiMAX-based PBR. These sidelobe structures have a deterministic nature mainly related to the OFDM modulation exploited by WiMAX transmissions. A proper filter, based on the

knowledge of the expected value of the signal Autocorrelation Function (ACF), is implemented to cope with this limitations and its performance is evaluated against simulated data generated according to the IEEE 802.16e Standard. The proposed approach is shown to yield an effective removal of the undesired peaks in the AF thus making the considered waveform more attractive for PBR medium range surveillance. [C239]

"New results on coherent radar target detection in heavy-tailed compound-Gaussian clutter"

In this work we prove that if the texture of compound-Gaussian clutter is modeled by an Inverse-Gamma distribution, the optimum detector is the optimum Gaussian matched filter detector compared to a data-dependent threshold that varies linearly with a quadratic statistic of the data. The compound-Gaussian model presented here varies parametrically from the Gaussian clutter model to a clutter model whose tails are evidently heavier than any K-distribution model. Moreover, we also show that the GLRT, which is a popular suboptimum detector due to its CFAR property, is in fact an optimum detector for our clutter model in the limit as the tails get extremely heavy. [C240]

"Detection performance comparison for wideband and narrowband radar in noise"

The detection performance of wideband radars in noise is better than that of the narrowband radars under some conditions, due to higher range resolution and less target return fluctuation. The detection probabilities of wideband and narrowband radars for the wideband non-fluctuation, Rayleigh and Ricean target models in white Gaussian noise are deduced. The detection curves show that the wideband radars outperform the narrowband radars in detection performance in the case of high detection probabilities. But the detection predominance of the wideband radars is meaningless when the bandwidth of the radar is increased to a certain extent, because the integration loss of the wideband radar energy integration detector is increased with the increasing range resolution. [C241]

"Validating multipath responses of moving targets through urban environments"

This work proceeds from the paper we published in RadarCon 2009 titled "Multistatic scattering from moving targets in multipath environments", where we explored the potential to track moving ground targets with radar as they enter urban areas and become obscured by buildings. An X-band radar data collection was performed which validates the predicted multipath response, and the received multipath power in relation to the line-of-sight (LOS) response. Results from a bistatic experiment are used to examine the spatial coherency of energy reflecting from a large, rough surface, and the power distribution in angle that illuminates a target as it traverses in front of a building. This experiment may inspire knowledge-based methods to coherently process multipath returns, beyond that of standard GMTI processing, i.e., free-space matched-filtering (FFT) and CFAR detection. [C242]

"Multi-modal sensor system integrating COTS technology for surveillance and tracking"

The feasibility of low-cost, Commercial Off-The-Shelf (COTS) sensor nodes is studied in a distributed network, aiming at dynamic surveillance and tracking of ground targets. Data acquisition by the low-cost (<;$50 US) miniature radar is described. We demonstrate the detection, ranging and velocity estimation capabilities of the mini-radar, and compare results to simulations. Furthermore, we integrate the radar output with supplementary sensor modalities, such as acoustic and vibration transducers, and infrared sensors. The method provides innovative solutions for detecting, identifying, and tracking vehicles and dismounts over a wide area in noisy conditions. This study presents a step towards distributed intelligent decision support and demonstrates effectiveness of small cheap sensors in identifying unique but similar events. Our work supports a pervasive sensor implementation relevant to the affordable open system architecture attribute of the U.S. Air Force Layered Sensing paradigm. [C243]

"Change detection of vehicle-sized targets in forest concealment using VHF- and UHF-band SAR"

We describe an extensive data collection and analysis of change detection using VHF- and UHF-band SAR data. Two airborne systems (CARABAS-II: 22-82 MHz, LORA: 225-470 MHz) acquired data for multiple headings and incidence angles. Twenty one targets of five types were deployed in forest concealment. CARABAS-II gives the best performance for the target types investigated. Analysis of the data shows that performance degrades for increasing incidence angle, mainly due to reduced target radar-cross section. It is also shown that different change detectors give different performance. The best detector for one incidence angle is not necessarily best for another incidence angle. [C244]

"Detection in heterogeneous clutter by filter output prediction"

This paper introduces an innovative method for ground moving target indication with a multichannel air or spaceborne radar. It is based on comparing the power of the filtered receive signal with a predicted power level. This prediction is found using data from the range line under test only. No potentially misleading prior magnitude information is employed. Thus, the false alarm probability is stabilized and the method is especially suited for rapidly varying heterogeneous terrain. [C245]

"ALR detector comparison with the Hough detector in a search radar"

In this paper, the disadvantages of using the Hough transform as a detector have been considered in a search radar. To illustrate the effect of these disadvantages on the performance of the detector, its performance has been compared with the optimum detectors. To do this, the Average Likelihood Ratio detector has been extracted for detecting a target line with a known normal parameter pair in the search environment. Then, the performance of this detector has been compared with the Hough detector by extracting their Receiver Operation Characteristics. The results of this comparison, which has been done through simulations, show that the Average Likelihood Ratio detector has a better performance. [C246]

"Mode-Selective OTHR: A new cost-effective sensor for maritime domain awareness"

This paper presents a new sensor concept designed to provide maritime domain awareness over large ocean areas. The Mode-Selective OTHR introduced herein achieves significant detection and tracking capability against maritime vessels relative to traditional OTHR designs because it is designed specifically to reject disturbed ionospheric propagation modes and operate only using low distortion propagation modes. The architecture of the radar is such that this rejection occurs for both the transmitter-to-surveillance-footprint and the footprint return-to-receiver propagation paths. This is achieved using recently discovered techniques for non-causal adaptive and range dependent transmit beamforming and two-dimensional apertures for both transmission and reception. It also includes new methods for using planar transmit arrays operating with extreme steer angle. [C247]

"Radar target detect using particle filter"

A radar target track-before-detect (TBD) algorithm using particle filter (PF) is presented in this paper. System dynamic model and measurement model are established based on a sequence of radar range-Doppler measurements using the new algorithm. Furthermore, a linear extended target model is proposed, which is more capable of describing a maneuvering target than the conventional point target model. The likelihood ratio function of the new model is also derived in this paper. Due to the accumulation of the PF-TBD over time and the effectiveness of the proposed target model, an improved probability of detection for dim target is obtained. The experimental simulations demonstrate that the proposed method is capable of detecting and tracking a target with SNR of 1 dB robustly. [C248]

"Characteristic analysis of vehicle target in Quad-Pol Radarsat-2 SAR images"

Radarsat-2 satellite offers general users the Quad-Pol SAR image service with a resolution of 8 meters, which provides valuable data source for the research of traffic vehicles monitoring on Quad-Pol SAR images. According to the vehicle target in such new SAR images, this paper put forward a target characteristic analysis method, which is a combination of target RCS measurement and polarization decomposition. Moreover, it choose the large trucks as an example, give out a conclusion of characteristic analysis of vehicle targets through the on-site synchronous experimental data obtained at different incident angle. Thus provides the research foundation for further exploration of realizing the traffic monitoring with space-born Quad-Pol SAR images. [C249]

"Impact of the wave number estimation in Underground Focusing SAR images"

This work studies the impact estimating soil wave number in Underground Focusing SAR imaging for tunnel detection applications. It is demonstrated that poor underground imaging results when wave refraction at the ground surface is neglected, but that incorporating refraction with sufficiently high estimates of soil dielectric constant produce clear target images. Using a wrong wave number for the soil incorrectly predicts the tunnel's depth, but gives positive identification of its transverse and extent. [C250]

"Hidden Markov based target detection for track-before-detect"

A tracking filter using conventional methods perform target detectios by setting a threshold at the output of the sensor's signal processor. The result of using thresholding brings out that, targets with low signal-to-noise ratio (SNR) may not be detected if the signal power is below the required threshold. Track-before-detect (TBD) techniques avoid the usage of a detection threshold and provide detecting and tracking targets with lower signal-to-noise ratios. Although TBD techniques eliminate the need for detection threshold at sensor's signal processing

stage, they often use tuning thresholds at the output of the filtering stage. This paper presents a Hidden Markov Model (HMM) based target detection method for employing with TBD techniques which does not use any of the thresholding method. [C251]

"Clutter detection algorithms for airborne pulse-Doppler radar"

Clutter detection is an important stage of target detection. Clutter may not always appear around zero Doppler frequency when realistic terrain models and moving platforms are considered. Two algorithms developed for clutter detection using range-Doppler matrix elements and their performance analysis are presented in this paper. The first algorithm has higher error rates but lower computational complexity whereas the second one has lower error rates but higher computational complexity. The algorithms detect clutter position by filtering range-Doppler matrix elements via non-linear filters. [C252]

"A comparison of experimental and modeled results of an active millimeter wave inverse synthetic aperture radar system used to perform standoff detection of person-borne improvised explosive devices"

With the recent rise in casualties resulting from person-borne improvised explosive devices (PBIEDs) or "suicide bombers," there is an urgent need for standoff detection of such threats. An optimum system that fulfills the requirements of standoff detection must be portable, low cost, and have a high probability of detection with low probability of false alarm at a distance of at least 20 meters. Currently there are a variety of modalities being researched to perform standoff detection of PBIED's including: backscatter X-ray imaging, infrared imaging, optical detection, terahertz imaging, video analytics, and millimeter-wave (MMW) imaging. MMW imaging at 94 GHz is a very good modality for performing standoff detection of PBIEDs. MMWs can propagate through the atmosphere and clothing with very little attenuation, while at the same time do not cause damage to human skin tissue. A mono-static linear frequency modulated continuous wave (LFMCW) circular inverse synthetic aperture radar (ISAR) system has been developed and tested. A model of such a system using a two dimensional full wave analysis based on the finite difference method in the frequency domain has been developed and compared with results of the experimental system. Using a two dimensional matched filtering technique in the frequency domain, simulated images have been used as a means of performing target detection and classification. The imaging results of both simulated and experimentally obtained data is presented in this paper. Initial results using the 2D matched filtering target classification technique will also be presented. [C253]

"Automatic target recognition based on neutral networks"

Several researches published about artificial neural networks are connected with military problems. This research put forward ideas connected with the processing of military information to search and identify targets-automatic target recognition (ATR). A main-purpose automatic target recognition system did not exist. The research put forward here was demonstrated on military data, however it could only be considered as a proof of principle until systems were fielded and proven "under-fire". A TR data could be in the form of non-imaging one-dimensional sensor returns, such as ultra-high range resolution radar returns for air-to-air automatic target recognition and vibration signatures from laser radar for recognition of ground targets. The ATR data could be two-dimensional images. The most common ATR images were infrared, but current systems might also deal with synthetic aperture radar images. Finally, the data could be three-dimensional, such as sequences of multiple exposures taken over time from a no stationary world. [C254]

"Moving target refocusing algorithm for synthetic aperture radar images"

In the area of SAR imaging, it is of interest to be able to focus moving targets. In this paper, an algorithm for moving target focusing is presented. The algorithm is able to refocus a smeared moving target in a SAR image processed at one relative speed to the correct one% The algorithm works in the frequency domain and is based on the Range Migration algorithm. The refocusing can be made on the whole SAR image or small sub images corresponding to physical areas of interest for the end user. By applying the algorithm to a small image, the computational cost is greatly reduced compared with using the full SAR image. The performance is illustrated by applying the algorithm to simulated SAR data according to the parameters for the LORA system. [C255]

"Detection of land subsidence in Beijing, China, using Interferometric Point Target Analysis technique"

Land subsidence in Beijing is supposed to be caused by over-exploitation of ground water, which is leading to a rapid decline of water levels, drying out clay layers that finally result in land subsidence. The Interferometric Point Target Analysis (IPTA) is an advanced method to monitor vertical motion of the land surface over time. IPTA

identifies backscattering objects, named as coherent points or points targets, at the ground surface that persistently reflect radar radiation emitted by the SAR antenna. The core component of the IPTA technique is the iterative estimation of phase differences for all measurement points over the sets of the SAR data using a linear model. In this paper, IPTA technique was used to retrieve the phase history, extract the linear deformation information from interferometry phase and weaken atmosphere phase delay in Beijing. 20 ENVISAT ASAR images acquired between June-18-2003 and March-14-2007 have been selected. The intention of this article is to demonstrate how IPTA technique could be used to extract valuable information in Beijing area. [C256]

"Radar-based human detection and characterization with non-linear phase modeling"

Many current radar-based human detection systems employ some type of Doppler or Fourier-based processing, followed by spectrogram and gait analysis to classify detected targets. However, in Fourier-based techniques the maximum output signal-to-noise ratio (SNR) is given by targets whose target phase is linear. On the contrary, the phase variation of the human target response is nonlinear. This difference causes a significant loss in SNR, and therefore detection performance. In this paper, two novel, nonlinear phase detector designs based on human modeling are presented. In the first method, only the human torso reflections are modeled and unknown model parameters computed using Maximum Likelihood Estimation. In the second method, the entire human body is modeled as a different parametric model. The expected radar response for each combination of parameter values is stored in a database. An optimal sparse approximation to the data is found using Orthogonal Matching Pursuit. The performance of the proposed techniques and optimal space-time adaptive processing algorithm is compared and target characterization applications examined. [C257]

"Target detection above rough surfaces in microwave imaging using Compressive Sampling"

A subspace extraction approach for detection of targets embedded in the clutter is presented in this work. Subspace extraction approach that makes use of both Compressive Sampling and Principal Component Analysis (PCA) is presented in this paper. Inverse Synthetic Aperture Radar (ISAR) Imaging measurement data is used to validate the proposed approach. Experimental results of targets above rough surface with intermediate roughness are presented. Results showed the dimensionality of an intermediate scale rough surface is generally larger than the dimensionality of the finite size targets. Results showed that by compressing the dimensionality through compressive sampling and extracting the principal components, significant improvement in target subspace extraction can be achieved. [C258]

"Investigation on moving target detection and velocity estimation with Triple-Channel MIMO-SAR"

Triple-Channel SAR system can detect moving target, and estimate its range velocity. However, the problems of blind velocity and velocity ambiguity still exit. To resolve these problems, Triple-Channel Multi-Input Multi-Output SAR (Triple-Channel MIMO-SAR) system, with a displaced phase center antenna (DPCA) and interferometry method based on matched Fourier Transform (MFT), is proposed in this paper, which could combine detection and estimation results of different working frequencies and obtain accurate Doppler frequency modulated rate estimation. Using this method, we can not only detect moving target and estimate its range velocity, but also resolve the problems of blind velocity and velocity ambiguity and get accurate azimuth velocity estimation. The effectiveness of this approach is validated by the computer simulation results. [C259]

"Passive infrared localization with a Probability Hypothesis Density filter"

In passive infrared localization (PIL) humans are located based on their thermal radiation. Thus, an active tag is not required and privacy is guaranteed due to non-identifying sensors. However, in case of multi-target tracking, the non-identifying sensors result in missing associations between targets and measurements. As additionally the number of humans in the surveillance region is unknown and varying, conventional localization approaches like the JPDA or MHT filter cannot be applied since they require a fixed number of targets or are not tractable. The Probability Hypothesis Density (PHD) filter, on the other hand, that propagates only the first order moment of the multitarget probability distribution offers an efficient and elegant way to handle the aspects of missing association and varying target number. Furthermore, false measurements as well as missed detection are considered implicitly. In this paper we present an implementation of this filter for PIL that allows an accurate and reliable tracking of several humans. The accuracy and reliability are evaluated under the influence of noise. Thus, several simulations and real measurements are carried out that reveal a mean error of less than 30 cm in case of three humans. Moreover, efficiency tests show that on standard PCs update rates of more than 50 Hz are achievable. [C260]

"Roll invariant target detection based on PolSAR clutter models"

Based on the Kennaugh-Huynen decomposition, the Target Scattering Vector Model (TSVM) allows to extract

four roll-invariant parameters. Those parameters are necessary for an unambiguous description of the target scattering mechanism. The proposed method consists in applying the TSVM prior to the GLRT-LQ detector for the detection of any oriented target. [C261]

"Detecting depolarizing targets with satellite data: A new geometrical perturbation filter"

Target detectors using polarimetry are often focused on single (coherent) targets, since these are the ones that can be more simply characterized polarimetrically. The new proposed algorithm is aimed at the more difficult problem of partial target detection (i.e. targets with any degree of polarization). A new feature vector is defined starting from the coherency matrix, and then a perturbation method is performed. Starting from the partial target detection, a novel classification algorithm is proposed. The validation is carried out against fully polarimetric satellite data. In particular, X band TerraSAR-X and L band ALOS PALSAR are employed, providing significant agreement with the expected results and the supervised Wishart classifier. [C262]

"An improved algorithm for passive bistatic radar detection and parameters estimation"

In passive bistatic radar system, both detection and joint estimation of time delay and Doppler shift of target are based on the cross-ambiguity function (CAF) between direct-path signals and target echoes. However, the drawback of this approach is the excessive processing load which is caused by the fast Fourier transforms (FFT) for long input samples. Since the interested frequencies of target often occupy a small portion of the whole frequency range, it only required to analyze the sub-band of the whole frequency. A decimation technique which can decrease the operation complexity was applied to solve this issue. The cascaded integrator-comb filter (CIC filter) theory was briefly introduced, followed by detailed signal processing procedures used to implement the target detection and parameters estimation. This improved algorithm needs several extra steps to decimate the signals, while greatly reduces the overall computation complexity with almost no loss of signal processing gain. Finally, the effectiveness of this proposed algorithm is verified by the real data analysis. [C263]

"Impacts of Keystone formatting on Space-Time Adpative Processing in airborne radar"

Keystone formatting (KF) has the capability of compensating multiple targets' (including ground clutter) range walk simultaneously without using any specific knowledge of the target motion. However, due to serious Doppler ambiguity of the fast moving targets, KF will affect the distribution of the clutter and degrade the Space-Time Adaptive Processing (STAP) performance. Based on the above reasons, the impacts of KF on the clutter distribution are analyzed firstly, and then the impacts of KF on STAP are analyzed. The conclusions obtained are helpful to figure out better methods for fast dim air moving target detection. [C264]

"Multiple/Distributed Target Detection for HRR"

Side lobe suppression is extremely important in precisely determining the weak echo scattering region in the presence of range side lobes. This paper addresses the signal design problem for the detection of multiple/distributed targets in high resolution radar (HRR) application with improved side lobe suppression ratio. The simulation results indicate a significant improvement in terms of noise tolerance for HRR target detection; compared to conventional binary sequences. [C265]

"Two-Thresholds CFAR detection of the range-spread target based on scattering centers accumulation"

This paper concerns the detection algorithms based on the HRR component of detecting range spread target in white Gaussian noise and designs a detector. By setting a higher false alarm probability, we can obtain the first threshold and the information of the target scattering centers. Then we accumulate the energy of the cell with a scattering center and make use of the energy accumulation as the test statistic. The proposed detector shows a better performance compared with that of the integration detector and two-threshold GLRT detector for all the matched filter input SNR for a small value of the Nc and almost equals that of the Integration detector for a large value of the Nc. Both of the proposed detector and the Integration detector lose a little dB of the SNR comparing the BS_CLRT detector whiling the SNR below -30dB for a small Nc. The proposed detector could be applicable to the target with few scattering centers and propitious to the practical radar systems because of the general targets only with several scattering centers. [C266]

"A novel STAP method for the detection of fast dim air moving targets"

Space-time adaptive processing (STAP) is an effective method for moving target detection in airborne radar. In this paper, a novel STAP method for fast dim air moving target detection is proposed. The new method suppress clutter in the received data firstly, and then apply Keystone formatting (KF) to compensate the target's range

walk. Finally, target is accumulated by the conventional space-time beamforming. Effectiveness of the new method is verified via simulation examples. [C267]

"Research on Scan-GMTI technology of airborne MIMO radar based on STAP"

Through successive azimuth scanning with narrow beam steered to different angles, Scan-GMTI technology provides a significant way to implement wide-area surveillance and track a particular target simultaneously. Applying MIMO mode to Scan-GMTI, abundance channel and frequency resources provide significant advantages for STAP algorithm to implement. The space-time-frequency joint processing will provide an effective approach for improvement of detection of slowly moving targets, reduction of Doppler ambiguities and blind velocities. [C268]

"The imaging research of the ground moving targets in forward scattering radar"

The present shadow inverse synthetic aperture radar (SISAR) imaging algorithm is derived based on some assumptions for air moving objects such as long baseline, large target size and so on. For the forward scattering radar (FSR) system to detect ground moving targets, the assumption conditions are often unsatisfied because of relatively small objects size, the strong ground clutter and the short baseline length. Furthermore, the assumptions will result in distorted imaging results for the extraction of profile median line and height difference using the present imaging algorithm. To obtain the accurate imaging results of ground moving target, the more accurate signal model for ground moving target is first time presented based on Fresnel-Kirchhoff diffraction formula and high order phase approximation methods, and the modified imaging algorithm is also proposed for the accurate profile reconstruction of ground moving target. Finally, the effectiveness is verified by simulation results. [C269]

"Target detection of high-resolution radar in non-Gaussian clutter"

The high-resolution radar echo is modeled as a range-spread target. Based on the generalized likelihood ratio test design procedure, the range-spread target detection in spherically invariant random vector clutter is addressed. And a binary integrator with constant false alarm rate property is proposed to detect the whole range-spread target, after single target scatterer detection in each range cell. Finally, the performance assessment shows that, the detection performance is improved as the number of sensors used or the clutter spike increases, while it is robust to the clutter correlation. [C270]

"A CKF based spatial alignment of radar and infrared sensors"

Spatial alignment is the prerequisite for the successful data fusion of multiple sensors. A CKF based spatial alignment algorithm for the estimation of bias between radar and infrared sensors on a same platform is presented. The system dynamics of this problem is established in a hybrid coordinate, i.e., the target position in the spherical coordinate while the target speed in the Cartesian one. The system bias is then estimated by the cubature Kalman filter (CKF) in an augmented system state equation. Simulation results show that the proposed algorithm is effective and efficient. [C271]

"Generalized likelihood ratio test for distributed targets in heterogeneous environments"

Adaptive detection for distributed target or targets in non-homogeneous environments is studied in this paper. It is assumed that the covariance matrix of the secondary data Msis a random matrix following inverse Wishart distribution with its conditional expectation proportional to that of the primary data, i.e. E(Ms| Mp)= γMp. Firstly, the maximum likelihood estimator (MLE) of Mp, γ and target amplitudes are given and the generalized likelihood ratio test (GLRT) are proposed subsequently, which turns out to be in the form of the summed adaptive coherence estimator (ACE). The detector is coincident with the generalized adaptive subspace detector (GASD) based on deterministic unknown covariance matrix and it has CFAR property. When the target exists only in one range bin, the detector is boiled down into the ACE based on the partial homogeneous environments. [C272]

"Performance analysis of multiple signal detection using the ESPRIT algorithm"

An array antenna system with an innovative signal processing algorithm "Estimation of signal parameters via rotational invariant technique" (ESPRIT) is used in this paper to estimate the direction of arrival (DOA) for multiple targets. The DOA angles are derived indirectly from the generalized eigenvalues of the auto-correlation and cross-correlation matrices. The estimated autocorrelation and cross correlation matrices in this study are based on a combination of temporal averaging and spatial smoothing method. Two different methods of estimating the multi-signal DOA are: (1) Choice of appropriate pairs of generalized eigenvalues from the two sub-arrays according to their relative distance from the unit circle, and (2) Choice of appropriate pairs of

generalized eigenvalues from the two sub-arrays according to their Euclidean distances [1]. Since the performance of the second approach provides a better estimation, it is used in this simulation study. A 19-element array antenna is used in this simulation study. Extensive computer simulations are used to demonstrate the performance of the processing algorithms. The DOA performance as a function of signal to noise ratio (SNR) and varying numbers of snapshots is presented in this paper. [C273]

"Cross-correlation detection and time difference estimation in non-cooperative bistatic radar systems"

In this paper, the basic geometrical relationship and signal energy relationship of non-cooperative bistatic radar are introduced, and the method using the cross-correlation to obtain the time difference of direct signals and target scattering echoes in noisy environment is discussed. Some experiments have been done to simulate the process of cross-correlation detection and time difference estimation. What's more, on the basis of them, some parameters affecting the performance of the algorithm, such as the signal-noise ratio, pulse width and pulse number of cross-correlation, are analyzed by Monte Carlo simulation. [C274]

"Weber-Haykin based Automatic Censoring and detection in Weibull background"

In this paper, we study the problem of automatic target detection in Weibull clutter and multiple target situations, without any prior knowledge of neither the non-stationary clutter statistics in which the radar operates nor the number of outliers that may be present in the reference window. In doing this, we develop the Forward/Backward Order Statistic Automatic Censoring and Detection Constant False Censoring and Alarm Rates Detectors based upon the Weber-Haykin adaptive threshold (WH-based F/B-OSACD-CFCAR). These detectors select repeatedly a suitable set of ranked cells among reference cells surrounding the cell under test to estimate the unknown background level and set the adaptive threshold, accordingly. The censoring and detection performances are evaluated by means of Monte Carlo simulations. [C275]

"A micro-motion feature deception jamming method to ISAR"

One of the main features of IS AR target recognition is the micro-motion feature. In order to jamming target recognition of IS AR, a micro-motion feature deception jamming method to ISAR based on digital image synthesizer is presented in this paper. In this method, the constant Doppler frequency of the scatterer in the template of false-target is replaced by the time-varying micro-Doppler frequency that produced by micro-motion scatterer, and the intercepted radar signals are modulated by the modified template of false-target in the slow time. The research results shows that this method can add the micro-motion information to the echoes of rigid body targets, and realize the micro-motion feature deception jamming to ISAR, Furthermore, the validity of the jamming method is justified by simulation experiment. [C276]

"Design based on MCU for the echo simulator of the range extended target"

It is important for the high resolution radar to design the simulator for generating the echoes of the range extended target. In this paper, a simulator design which is based on Micro Controller Unit (MCU) is proposed for generating the echoes of the range extended target. Because those echoes change rapidly and the corresponding period is longer, the high speed FIFO is selected as the data cache. In the idle time of system, waveform data is transferred from MCU to FIFO, whereas in the operating time of system it is transferred from FIFO to D/A converter at a high speed in order to output the waveform. The experimental results show the design can meet the purpose of the echo simulator of range extended target. [C277]

"Orthogonal polarimetric SAR processor based on signal and interference subspace models"

We develop a new SAR processor based on several orthogonal projections.We take into account the scattering properties of the target and the interferences by using subspace models. To detect the target without detecting the interferences, we process images from the orthogonal projection of the received signal into the target subspace and from the orthogonal projection of the received signal into a part of the interference subspace. We can combine these two images to firstly detect the target and to secondly reduce interference. This new SAR processor is applied to realistic simulated data for FoPen (Foliage Penetration) application. [C278]

"CASA dual-doppler system"

Conventional radar networks are limited at warning against low-altitude wind hazards such as tornadoes and micro-bursts due to the combined effects of their long range, far spacing, and Earth's curvature. The Collaborative Adaptive Sensing of the Atmosphere (CASA) Engineering Research Center aims to solve these limitations through dual-Doppler systems operating in densely-spaced short range radar networks. The CASA

test bed radar network incorporate the Distributed Collaborative Adaptive Sensing (DCAS) model in order to optimize scanning and retrieval for fast Doppler wind field products. Under the DCAS environment, fast coordinated sector scans are made by each radar based on weather detection and competitive end-user needs. The retrieval subsystem then makes the best pair selection for dual-Doppler synthesis based on optimal beam-crossing angles for target areas. Together, they create a fast, accurate, and robust dual-Doppler system suitable for weather emergency warnings. [C279]

"Using airborne lidar to retrieve crop structural parameters"

Airborne LIDAR (Light Detection and Ranging) is an active remote sensing technique that measures the properties of scattered light to determine the range and intensity information of a distant target. Many studies have been reported on estimating a suite of forest characteristics such as fractional vegetation cover, leaf area index and canopy height using LIDAR data. The three characteristics of crop canopy also play key roles in vegetation radiative transfer models and yield estimation. But crops are so small and low that more than 95% pulses have ground hit, it is difficult to separate the crop and soil completely, so the methods used in forest may not be suitable for crops. In this paper, based on theoretical analysis, we propose a new method, trying to derive gap fraction of crop field using the airborne LIDAR intensity of ground hits, so we can manage to retrieve the fractional vegetation cover, LAI and the height of crop canopy. We choose corn field as study object, field validation shows that our method can accurately retrieve the three structural parameters of corn field. This study documents the great potential of LIDAR remote sensing for accurately characterizing crop canopies. [C280]

"Ground penetrating radar measurements: Applications to synthetic data generation and target characterization"

Ground penetrating radar (GPR) is widely studied for detection of landmines and mine-like targets; GPR is particularly useful for detecting minimum metal mines which are harder to detect using traditional metal detection devices alone. In order to expand the phenomenology for GPR, careful measurements of homogeneous and heterogeneous soils with and without targets (landmine simulants and metal objects) are performed in a controlled environment. These measurements will aid in the development of models for soil response beyond the initial air-ground interface. Such explicit models for soil will increase the effectiveness of algorithms designed to discriminate between returns from targets and from naturally occurring geologic materials and interfaces. Furthermore, careful measurement of soil characteristics will enable comparison and refinement of models of soil with embedded targets developed in electromagnetic simulations (using finite-difference time-domain codes (FDTD), e.g.). [C281]

"Vision-based detection and tracking of aerial targets for UAV collision avoidance"

Machine vision represents a particularly attractive solution for sensing and detecting potential collision-course targets due to the relatively low cost, size, weight, and power requirements of the sensors involved (as opposed to radar). This paper describes the development and evaluation of a vision-based collision detection algorithm suitable for fixed-wing aerial robotics. The system was evaluated using highly realistic vision data of the moments leading up to a collision. Based on the collected data, our detection approaches were able to detect targets at distances ranging from 400m to about 900m. These distances (with some assumptions about closing speeds and aircraft trajectories) translate to an advanced warning of between 8-10 seconds ahead of impact, which approaches the 12.5 second response time recommended for human pilots. We make use of the enormous potential of graphic processing units to achieve processing rates of 30Hz (for images of size 1024-by-768). Currently, integration in the final platform is under way. [C282]

"Ship detection with RadarSat-2 Quad-Pol sar data using a notch filter based on perturbation analysis"

Target detection of marine feature is a major topic for the security and monitoring of coastlines. Synthetic Aperture Radar (SAR) has been shown to be particularly useful for this application because of its all-weather and night capability. In this paper a new ship and iceberg detection methodology is described. The algorithm proposed is based on a perturbation analysis in the target space recently developed and published by the authors, which was focused on land based target detection. The algorithm can be considered to be a negative filter focused on sea. Consequently, all the features which have a polarimetric behaviour different from the sea are detected. To demonstrate and validate the technique two RadarSat Fine Quad-Pol mode scenes were acquired off the south coast of the UK at Portsmouth harbour. An extensive ground truth campaign was also conducted that was coincident with these acquisitions. Portsmouth is one of the busiest harbours in the UK and this afforded the opportunity to capture a wide range of vessel sizes and types for analysis. [C283]

"Morphological-based source extraction method for HFSW radar ship detection"

In this contribution, High Frequency Surface Wave (HFSW) radars are considered for target detection. These systems, commonly used for oceanographic purposes, are of interest in maritime surveillance because of their long range detection capabilities. Unfortunately, the received signals are strongly polluted by different noises. To improve target detection a method based on Morphological Component Analysis (MCA) is investigated. Shortly, this paper introduces HFSW radars and gives an overview of the MCA. Then, numerical results from simulated data illustrate the MCA-based target detection method. Comparisons with classical detection methods based on CFAR techniques (GOCA-CFAR and GOOS-CFAR) are proposed through Receiver Operating Characteristics (ROC) curves. [C284]

"Application of the moving target detection by focusing technique in civil traffic monitoring"

This paper presents an application of the moving target detection by focusing technique (MTDF) in civil traffic monitoring. The experimental results based on simulations show that the basic civil traffic monitoring can be solved using MTDF using a single-channel airborne SAR system. With an assumption of known moving directions of vehicles, MTDF allows detecting, estimation of speed, and finally reconstructing a SAR image of the vehicles of interest. In this study, the focusing approach of MTDF is based on ultrawideband chirp scaling (UCS) algorithm. [C285]

"DVB-T passive radar for vehicles detection in urban environment"

Passive radar systems exploit non-cooperative transmitter to detect targets in areas of interest. Some of the main advantages of such systems with respect to conventional radars include low cost architectures, low energy requirements and potentially null probability of intercept. In this paper a low-cost solution for vehicles detection making use of passive radar concept is presented. A Software Defined Radio (SDR) solution and commercial antennas have been used to realize a DVB-T passive radar demonstrator. An analysis of the DVB-T signal is firstly presented together with a study of its capability as radar waveform. Afterwards an experimental setup is presented and analysed and finally some results of targets detection are shown. [C286]

"Oblique polarimetric SAR processor based on signal and interference subspace models"

We develop a new SAR processor based on oblique projection. We take into account the scattering properties of the target and the interferences by using subspace models. To detect the target and to reject the interferences, we process images with the oblique projection of the received signal into the target subspace along the interference one. This new SAR processor is applied to realistic simulated data for FoPen (Foliage Penetration) application. [C287]

"ESA Earth Observation educational tools contribution to the creation of awareness for World Heritage site conservation"

EO from space is a key tool to assess the effects of anthropogenic activities to our planet (e.g. deforestation, urban growth). It can provide measurements supporting the process of sustainable development, or observations allowing the detection of changes in the surface of our planet related to climate change. UNESCO and ESA have launched a call to all national and international space agencies, space research institutions and universities to make use of space technologies in order to assist developing countries in the monitoring of the World Heritage sites. ESA and UNESCO are also covering associated educational aspects by using all the results of the projects under implementation as educational material to support UNESCO's `UN decade for education and sustainable development', within a common and joint strategy of education, targeting schools, universities and young professionals. This includes creating new tools for the creation of awareness and savoir-faire in the use of space technology for the conservation and preservation of the environment and for a sustainable development. Material derived from satellite images provided to decision makers is also being used to support teachers and school children from the surroundings of the World Heritage sites where the space partners of the `Open Initiative' are working. In the frame of its educational activities for Earth Observation, ESA is creating particular modules oriented to UNESCO sites. All this material comes out of the different activities being implemented by partners of the ESA-UNESCO `Open Initiative', in complete integration with the EDUSPACE programme of ESA, a platform and web-based tool for Earth Observation Education, in eight different languages, available for free to worldwide secondary schools teachers and students, aiming to provide schools with tools for teaching and learning. It offers an entry point to Earth Observation satellite data and software applications for training. The website is-- host to a multitude of didactical material inclusive high-resolution local and lower resolution global remote sensing satellite data in order to show students how to study the planet as a whole from space as well as the possibility of zooming into specific areas and natural features to investigate their behaviour over space

and time. An image processing tool called LEOWorks (Learning Earth Observation), including a GIS, soon in open source, is made available for data analysis and image interpretation. New dedicated content, like case studies and projects dedicated to the monitoring of UNESCO archaeological sites and to sustainable development are presently under development. [C288]

"Observation of a boat and its wake with a Dual-Beam along-track interferometric sar"

The Dual-Beam Interferometer is an airborne instrument that combines two along-track interferometric synthetic aperture radars observing the surface below at different squints. This configuration allows retrieving vector velocities of surface flows in a single aircraft pass. The system was designed by the University of Massachusetts and saw several deployments in the early 2000s. An imagery of a boat with a rather pronounced wake system captured during one of these flights is the subject of this paper. The velocity of the vessel is estimated based on the "train off the tracks" displacement in one of the looks. This estimate, which will be affected by uncertainty in target position due to smearing, is then used to remove unknown phase biases in the interferometric channels. Retrieved velocity variations are examined along cuts traversing the wake, with the focus on its narrow "turbulent" part. We find that the reconstructed velocities 150 m behind the boat are intuitively satisfying, but we are unable to fully account for the cross-wake component of velocity at 400 m behind the vessel. [C289]

"Target detection in missile warning receivers via speeded-up robust features approach"

Missile warning receivers are electronic support systems which are widely used for the protection of fixed and rotary wing aircraft against infrared guided missiles. Proposed methodology for the detection of missile threats in missile warning receivers depends upon the estimation of background from consecutive image frames. By removing the estimated background from the images, foreground objects (missile plume images) are detected. In this study, "Speeded-Up Robust Features (SURF)" methodology based on feature correspondence is used for the estimation of background motion. [C290]

"Advanced classification of UXO using fully polarimetric GPR and frequency-polarization features"

The classification of buried UXO has been a difficult task due to the large amount of false alarms resulted from troublesome clutter objects. This paper closely examined scattering characteristics of such clutter objects by using numerical simulations. From the numerical study, we found that some clutter objects, which mainly causes the false alarms, produce multiple resonances at different frequencies and different polarizations. Based on these observations, we developed new classification algorithms which utilize the frequency-polarization dependent responses of complex targets in order to discriminate UXO-like objects form such trouble some clutters. The developed algorithms were tested by experiments in a test plot. In the test, the new classification algorithms clearly discriminated such clutters from UXO-like targets. In this paper, we present the simulation results for scattering characteristics of complex clutters and the new classification algorithm based on frequency-polarization dependent responses will be discussed. Finally, results from experimental verification will be presented. [C291]

"Ground penetrating radar for tunnel detection"

Ground penetrating radar (GPR) systems have important civil and military applications and can be used for surveying subsurface structures such as bunkers, tunnels and buried pipes. However, GPR systems for detecting deep tunnels still face many challenges, and their performance often depends on soil types, specific targets and subsurface geological features. This paper discusses challenges in tunnel detection and provides a useful and efficient procedure to develop system requirements and predict detection performance. [C292]

"Operational evaluation of damages in flooded areas combining Cosmo-Skymed and multispectral optical images"

The management of a flood event requires singling out the affected area, quantifying the damages and programming an effective rescue plan. This requires rapid and easy access to all the geographical and observational information available for the target area. Optical imagery allow the identification of land uses, critical infrastructures and the extraction of important information to quantify the actual vulnerability of the area. In this case, the main advantage of satellite imagery is the much higher refresh rate with respect to classical in-situ surveys. When floods occur, the detection of flooded areas allowed by SAR observations such as those provided by Cosmo-SkyMed, helps in rapid and effective evaluation of the damage and organization of the management of the crisis. Here we present an integrated system developed by the team of the Italian Space Agency pilot project "Opera". The system allows the end user to integrate multispectral high resolution imagery and Cosmo-SkyMed products, in a 3-D environment, providing all the tools to virtually survey the observed area and extract quantitative information for many features relevant to the emergency management. The system has been tested

in real time on a prolonged flooding event occurred in Januray 2010 in the Shkoder plain in Albania. [C293]

"CFAR detection based on decision fusion of order statistic CFAR and order statistic clutter map CFAR processors"

In automatic target detection radars, adaptive constant false alarm rate (CFAR) processors, which determine the threshold, are examined. Two techniques are used for achieving the required CFAR. The first technique determines the adaptive threshold using range neighbouring cells which are located in sliding window. The second one is based on clutter map. In this technique, adaptive threshold is determined using the samples of test cell from previous scans which are assumed to contain no target. In this study, new techniques based on combining the two techniques in the data fusion system (DFS), are proposed. Analytical equations for homogeneous and nonhomogeneous environment are derived and performance analysis are carried out. [C294]

"Detection of rapid land subsidence of civil constructions with TerraSAR-X interferometry"

The TerraSAR-X SAR system provides high spatial resolution and geometric accuracy imagery which supports well the mapping of the 3-D structure of large-scale civil infrastructure and its motions (4-D). In this work, we investigated the potential of TerraSAR-X observations for monitoring rapid land subsidence induced by reclamation activities. A case study was conducted in Hong Kong Disneyland Theme Park (DTP) at the Penny's Bay, one of the largest land reclamation projects worldwide. A total of 16 TerraSAR-X scenes were used in a small-baseline PSI method for retrieving residual reclamation settlement in the study area. The preliminary results indicate that a remarkably high density of high coherent point targets (>2,500 PS point/km2) was identified in the reclamation area and a large land subsidence rate on the order of 35 cm/yr could be detected in the center of reclaimed land. The high detail level of deformation filed as well as the high sensitivity regarding rapid residual settlement makes TerraSAR-X interferometry a remarkable potential Earth Observation technique to enable the detection of ground deformation related to the large-scale infrastructure development in reclaimed land. [C295]

"Successive cancelation approach for Doppler frequency estimation in pulse Doppler radar systems"

In this paper, a successive cancellation approach is proposed to estimate Doppler frequencies of targets in pulse Doppler radar systems. This technique utilizes the Doppler domain waveform structure of the received signal coming from a point target after matched filtering and pulse Doppler processing steps. The proposed technique is an iterative algorithm. In each iteration, a target that minimizes a cost function is found, and the signal coming from that target is subtracted from the total received signal. These steps are repeated until there are no more targets. The global minimum value of the cost function in each iteration is found via particle swarm optimization (PSO). Performance of this technique is compared with the optimal maximum likelihood solution for various signal-to-noise ratio (SNR) values based on Monte Carlo simulations. [C296]

"Increasing airport security with the development of high accuracy location algorithms based on ray-tracing techniques over WLAN networks"

Airport security focuses on providing a cost effective and efficient operation to deliver high-quality and secure service to customers. For this, different technologies are deployed. For example, primary radar is used to detect airplanes during flight approach. Cameras, surface radar, and triangulation systems are deployed for ground surveillance. The ultimate goal of these systems is to improve the efficiency and safety of airport operations. However, airport areas where aircraft are parked, loaded, refueled, and boarded, present a high risk due to the large number of vehicles, goods and people involved in the aircraft handling activity. We propose different algorithms to improve location accuracy of vehicles and goods in critical airport areas where GPS satellite and radar coverage does not provide adequate target localization resolution. [C297]

"Advanced techniques and new high resolution SAR sensors for monitoring urban areas"

In the last years MultiDimensional (3D and 4D) Synthetic Aperture Radar (SAR) techniques, also known as SAR tomography and differential SAR tomography, are emerging in the field of coherent combination of multibaseline/multitemporal SAR data. With respect to the classical differential interferometric processing, these techniques improve the capability of detection and monitoring of the ground targets. Moreover they were proven to be effective in resolving the signal interference due to the layover effect, that may occur in areas with high density of scatterers located on vertical structures, such as urban areas. Beside the development of these advanced techniques the new generation of sensor, such as TerraSAR-X and COSMO-SKYMED with very high spatial resolution offer new perspectives in the imaging and monitoring of urban areas. In this paper we address

the application of the SAR tomography to real spaceborne data. Particularly, we show and discuss the first results of the application of this technique to high resolution TerraSAR-X data. [C298]

"Improved Variable Index constant false alarm rate radar processors"

In the cases when the statistical distribution of range return samples are not known, constant false alarm rate (CFAR) processors can be used. Cell Averaging (CA) CFAR radar processors which have the best performance in Gaussian homogeneous environments, exhibits performance degradation in the presence of an interfering target or in regions of abrupt change in the backround clutter power. The Greatest of (GO) CFAR radar processors are designed to control the false alarm rate, during the clutter power transition in the reference window (non-homogeneous clutter environment). The Smallest of (SO) CFAR radar processors improve detection performance when interfering targets exist in the environment but are unable to prevent excessive false alarm in non-homogeneous environments. Variable Index (VI) CFAR processors employs a composite approach based on CA-CFAR, SO-CFAR, GO-CFAR. Enhanced VI-CFAR (EVI-CFAR) radar processors proposed in this paper, shows performance improvement in different non-homogeneous environments when compared with VI-CFAR. [C299]

"Multi-baseline along track SAR interferometric systems for ground moving target indication"

In this paper we analyze the performance of ground moving target detection by means of single-baseline and dual-baseline along track interferometric synthetic aperture radar (SAR) systems, obtained using a generalized likelihood ratio test (GRLT). Detection performance are evaluated in terms of probability of detection and probability of false alarm using data simulated with TerraSAR-X parameters. [C300]

"Stap based ground moving target detectability in the airborne/spaceborne array radar"

A space-time adaptive processing (STAP) can be effective in detecting the ground moving targets from the airborne/spaceborne moving platform in the severe ground clutter and jammer environments. In this paper, the characteristics of target, ground clutter and jammer signals are analyzed and designed the adaptively weighted clutter notch filter in two dimensional spatial and temporal azimuth angle-Doppler domains. The simulation is performed for ground moving target detection by rejecting both clutter and jammer simultaneously through the STAP processing. The probability of target detection is investigated depending on the SNR and the minimum detectable velocity (MDV) in the given false alarm rate. The simulation results show that the MDV can be ideally achieved up to 2 m/s ~ 3 m/s at the 90 % of detection probability in the given false alarm rate of 10-3and 10-6. This technique may be applied for the surveillance and traffic monitoring of moving vehicle on the road. [C301]

"Target detection based on granularity computing of quotient space theory using SAR image"

Target detection is a hot topic and key technique of SAR image interpretation. There are many detection methods, such as CFAR detector and Extended Fractal (EF) feature detector. In order to overcome their shortcomings and combine their merits at the same time, the combination of some different detection methods need be implemented. Granularity computing is just an approach that solves the problem at different granularity space due to different principles. Therefore, SAR image target detection based on granularity synthetic algorithm of quotient space theory is proposed in this paper. Firstly, CFAR detector and EF feature detection method are performed to generate different detection results as coarse granularity spaces. Then combine the different quotient spaces and construct the fine granularity space by using granularity synthesis algorithm. Finally, obtain the final target detection result. The experimental result of RADARSAT-I C band SAR image proves that the proposed algorithm is effective. [C302]

"Space-time focusing of HF skywave radar signals with application to nonlinear scattering phenomenology"

Increasing the power density incident on a target without raising the radiated power may offer a number of benefits to HF skywave radar systems. Among these is the prospect of detecting nonlinear echoes, which could greatly enhance detection in sea clutter. Other prospects include improved detection of low RCS targets and more effective use of sub-apertures for multiple simultaneous task operations. In this paper we review the physics underlying these missions and assess the potential of various approaches to concentrating energy in localized regions within the illuminated zone. [C303]

"Time reversal adaptive waveform in MIMO radar"

EM multipath propagation is common in radar and wireless communications. Most radar systems are designed assuming line-of-sight (LOS), not multipath. In this paper, we extend our prior work on Multi-Input Multi-Output

(MIMO) radar in the absence of interference [1], to consider MIMO radar detection in high clutter. We develop a subspace MIMO target model and a statistical model for MIMO radar clutter that accounts for the spatial and spectral properties of radar returns. We show that, using orthogonal waveform signaling, the time reversal MIMO radar yields higher detection performance than conventional statistical MIMO radar in high clutter. [C304]

"Performance of cell averaging constant false alarm rate (CA-CFAR) processors for M-correlated sweeps in multiple target environments"

In this paper, the detection performance of CA-CFAR processor is analysed for M-correlated sweeps in Gaussian clutter environment which contains interfering targets. The performance analyses are done for different number of sweeps, M, and sweep-to-sweep correlation coefficient, R, with Swerling-I target model in homogeneous and non-homogeneous environments. [C305]

"Disaster mapping from medium spatial resolution alos palsar images"

All-day and all-weather Synthetic Aperture Radar (SAR) can measure both intensity and phase of the reflected signal. The backscattering coefficients measured by SAR reflect the backscatter characteristics of surface targets. Changes happened to a target's surface roughness, geometric and structural characteristics will result in the change of its backscattering intensity recorded in SAR image. The 2008 Wenchuan earthquake, China have caused widely distributed geological disasters, such as landslides, mudfloods and barrier lakes, which resulted in the difference between pre- and post-earthquake SAR images. Comparison between the pre- and post-earthquake SAR intensity images will reveal the damage information. In this study, PALSAR Level 1.0 data acquired for the Wenchuan earthquake were used to analyze the geological disasters. Results show that medium spatial resolution SAR data, such as 10 m resolution ALOS PALSAR data, especially when both pre- and post-earthquake images are available, are useful in revealing the distribution of landslides and barrier lakes. [C306]

"Target detection performance analysis for airborne passive bistatic radar"

For a ground-based/airborne passive bistatic radar, its performance is dependent on the geometrical configuration and the passive transmit signal attributes. Theoretical power budget and ambiguity function analysis using a ground-based non-cooperative transmitter of opportunity with a passive bistatic radar being airborne but stationary (airship, etc.) had shown that target detection performance is limited by the strong direct path coupling signal. In comparison, the bistatic ground clutter power is significantly lower and even more so for noise power. For the passive radar to perform satisfactorily, sufficient attenuation must be provided for the direct path and strong ground clutter signals, corresponding to increasing the height of the target peak on the ambiguity function pedestal. In addition, performance could also be improved by increasing the time-bandwidth product (assuming no target migration issues), which lowers the pedestal of the ambiguity function of the strong direct path interfering signal. [C307]

"Noise suppressions in chaotic lidars under different synchronization schemes"

Lidar has been extensively studied for its applications in target detection, range measurement, and imaging. Compare with other light source, chaotic lidar (CLIDAR) has the advantages of very high range resolution and never repeated waveform benefited by the broad-band chaotic waveform used. However, the channel noises between the transmitter and the receiver may decrease the quality of the correlation in the conventional chaotic lidar scheme. In this paper, we numerically study the resistances of the channel noise utilizing chaos synchronization in different schemes. [C308]

"A New Method of Bridge Target Detection on ASAR Imagery"

The result of linear target detection is advantageous to the content analysis and interpretation of ASAR imagery and can be regarded as the imagery matching reference as well as the GIS platform input to realize the map automatic update. On the foundation of the previous studies, the method of bridge target detection based on Combined wavelet transformation and mathematical morphology analysis is proposed according to the good local characteristic, multi-resolution and effectiveness of wavelet transformation in this article, and the result is revised by combining the fine characteristics of different methods, which is applied to ASAR data of Zhaoqing and Zhuhai of China for carrying on the bridge detection as well as the comparative experiment with classical methods, such as Sobel and Canny etc detection operators. Results indicate that the combined methods can detect the target bridge perfectly on the direction and size, at the same time can restrain the target missing and false warning. [C309]

"An Efficient Frequency-Domain Velocity-Filter Implementation for Dim Target Detection"

An efficient Fourier-domain implementation of the velocity filter is presented. The Sliding Discrete Fourier Transform (SDFT) is exploited to yield a Track-Before-Detect (TBD) algorithm with a complexity that is independent of the filter integration time. As a consequence, dim targets near the noise floor of acquisition or surveillance sensors may be detected, and their states estimated, at a relatively low computational cost. The performance of the method is demonstrated using real sensor data. When processing the acquired data, the SDFT implementation is approximately 3 times faster than the equivalent Fast Fourier Transform (FFT) implementation and 16 times faster than the corresponding spatiotemporal implementation. [C310]

"A Novel Application of Support Vector Machines to Detect Targets"

In this paper we develop a novel pulse radar detection scheme using Support Vector Machines (SVMs). SVMs are a powerful tool for pattern classification. Exploiting this, we design a SVM for pulse radar detection of targets embedded in noise. An adaptive pre-processing stage is included when the echoes are very weak. It is observed that the signal-to-side lobe ratio obtained is much higher compared to neural network based pulse radar detection schemes. We further examine the noise tolerance, range resolution ability and Doppler tolerance of the new algorithm for pulse compression, and compare it with the ones available in literature. [C311]

"Compressed sensing moving target detection for MIMO radar with widely spaced antennas"

The moving target detection based on compressed sending (CS) multiple-input multiple output (MIMO) radar with widely separated antennas is studied. The centralized processing is considered. The traditional centralized MIMO radar requires an exhaustive search on every possible two dimensional target velocity, resulting in huge computational complexity. In this paper, we adopt the CS technique to drastically reduce the computational burden and evaluate the reduction of the required complexity. We derive the moving target detector for the CS MIMO radar. The performance of the proposed detector is analyzed, and the receiver operating characteristic (ROC) curves are provided. [C312]

"Adaptive polarimetric MIMO radar detection"

This paper mainly deals with the target detecting problem using polarimetric Multiple Input and Multiple Output (MIMO) radar with unknown covariance matrix. And the GLRT-based receiver is devised by resorting to the two-step design procedure. Specifically, the GLRT is devised with known covariance, and then, a suitable estimate of covariance is obtained using secondary data to plug into the derived test. The performance is assessed by several numerical examples, and the results show that polarimetric diversity can be exploited to enhance the performance of detection. Moreover, the adaptive loss is acceptable. [C313]

"A novel application for sum-difference pattern detection of signal direction using time-modulated linear arrays"

A novel application using the time-modulated linear arrays (TMLAs) in determining the direction of unknown signal with sum pattern and difference pattern for tracking radar is presented in this paper. An optimized time sequence from the differential evolution (DE) algorithm is presented to produce multiple beams simultaneously. Based on the multiple beams of the sum patterns and their corresponding difference patterns at different sidebands, the directions of incoming signals can be detect. The comparison of the performance between TMLA and conventional antenna arrays under the same parameter demonstrate that the accuracy of the direction of target in TMLA is relatively high, and the range of angle detection is several times larger than those of the conventional antennas arrays. [C314]

"Polarization Filtering Based Interference Suppressions for Cooperative Radar Sensor Network"

The radar members are likely to interfere with each other if their waveforms and polarized states are not orthogonal in radar sensor network (RSN). In this paper, we propose the oblique projection polarization filtering (OPPF) based interference suppressions for RSN where each radar member is equipped with the orthogonally dual-polarized antenna (ODPA). In our discussed cooperative environment, under which radar members share their polarized states, members radiate EM waves using the same waveform but different polarized states, however, their polarized states are not needed to be orthogonal. Doppler-Shift and its uncertainty are not involved due to the independence from the polarized state, which makes the proposed method simple and effective. The results demonstrate that, after passing through the proposed OPPF scheme, each radar member can effectively suppress the echoes from the others while keep its own amplitude and phase unchanged, which improves the target detection performance of the RSN. Theoretical analysis is done, and the simulation results are illustrated, both showing the proposed method suitable for suppressing interferences for RSN. [C315]

"Multi-target tracking using proximity sensors"

We consider the problem of tracking multiple moving targets in a continuous field using proximity sensors, which are binary sensors that can sense target presence by performing local energy detection subject to noise. Compared with more sophisticated sensors, proximity sensors have the advantage of having lower costs and lower energy consumption, but also the disadvantage of being less accurate. In this paper, we propose a hybrid tracking scheme where a coarse-scale tracking is first performed by proximity sensors to narrow down the areas of interest, and then a fine-scale tracking is performed by high-end sensors to estimate the exact target locations, with our focus on the former. In contrast to classic multi-target tracking which assumes 1-1 association between measurements and targets, we show that proximity measurements do not have such association and thus require a different objective. Formulating the coarse-scale tracking as a problem of tracking the histograms of targets in a cell-partitioned field, we develop both an optimal and two approximate solutions via Bayesian Filtering (BF). In particular, one of our approximate solutions decouples the tracking of different targets and thus reduces the dimensionality of BF by relaxing the likelihood function, and the other further reduces the problem into discrete space by quantizing the target mobility model and the relaxed likelihood function. Together with the optimal solution, they provide flexible tradeoffs between accuracy and complexity. Simulations show that the proposed solutions can effectively track targets to the accuracy of a cell and thus reduce uncertainty for the fine-scale tracking. [C316]

"Robust target estimation in compressive sensing based colocated MIMO radar"

A colocated multiple-input multiple-output (MIMO) radar system is considered, in which the transmitters and receivers are nodes of a small scale wireless network. The sparsity of targets in the illuminated space allows target detection based on compressive sensing (CS) techniques. A receive node compresses the received signal via a linear transformation, Φ, referred to in CS theory a measurement matrix. The compressed samples are subsequently forwarded to a fusion center, where an ℓ1-optimization problem is formulated and solved for target information. CS-based MIMO radar achieves the same localization performance as do traditional methods but with many fewer measurements. Unlike previous work, we consider the case in which the targets might be located across several range bins, and the delay of the first reflected signal is unknown and, due to the small number of compressed samples, cannot be estimated accurately. A new measurement matrix is proposed that is constructed based on the transmit signal waveforms and also accounts for all possible discretized delays of target returns within a given time window. It is shown that reduced bandwidth transmit waveforms can lead to a measurement matrix that improves signal-to-interference ratio (SIR), but on the other hand, using waveforms that are too narrowband increases the coherence of the sensing matrix, thus invalidating the conditions for the application of the CS approach. Therefore, the transmit waveforms must be chosen carefully to guarantee the desired performance. [C317]

"Performance Analysis of Communications & Radar Coexistence in a Covert UWB OSA System"

Far-field target detection, multi-sensor communications, and security are essential requirements of first-emergency networks. A radar-communications system is a potential opportunistic spectrum access (OSA) solution, harnessing the coexisting advantages of radio detection and ranging (RADAR), and wireless communications. A multi-functional waveform has been designed, by embedding an Orthogonal Frequency Division Multiplexing (OFDM) signal within a spectrally notched ultra-wideband (UWB) random noise waveform. Extending that development, this paper analyzes the waveform's Bit-Error-Rate (BER) and Ambiguity Function (AF) formulations to demonstrate its OSA ability, that offers reliable multi-user communications, and high range and Doppler resolution in target detection. We further conclude that up to 30% of the available UWB bandwidth can be simultaneously utilized for concealed data communications without adversely affecting radar performance or its physical layer covertness. [C318]

"Speckle noise reduction in SAR images using adaptive morphological filter"

Speckle noise is one of the most critical disturbances that alter the quality of Synthetic Aperture Radar (SAR) coherent images. Before using SAR images in automatic target detection and recognition, the first step is to reduce the effect of speckle noise. Several adaptive and non-adaptive filters are widely used for despeckling in SAR images. In this paper, an adaptive mathematical morphological filter is proposed to reduce the speckle noise in SAR images. The new filter performance is compared with a number of despeckling filters with different parameters. For performance measurements, several parameters were evaluated to test the filter ability to attenuate the speckle noise and keep target information. From experimental results, the new proposed morphological filter gives promising results for significantly suppressing speckle noise and preserving the potential targets. [C319]

"Stability criterion of angle tracking systems in real time under conditions of interference distorting direction finding characteristic"

The article considers stability of the automatic angle tracking systems under conditions of interference distorting direction finding characteristic. The automatic angle tracking is described in the system state. Since the estimation of the modulus of continuity in the theorem on continuous dependence of the characteristic roots on matrix elements accepts very significant roots change under small matrix perturbations of the such that these perturbations cannot be simulated by computer, hence, the stability criteria based on characteristic roots location analysis are not always convenient for practical applications. In this article a stability criterion is proposed which is determined by solving the differential equation system of the system. A computational procedure is obtained which allows us to determine the stability of automatic control system in real time. The solution is not sensitive to significant changes in the characteristic roots under small matrix perturbations of the system. Well-timed detection of the forthcoming loss of the automatic target tracking provides an opportunity to protect the system in automatic mode and therefore minimize jamming effects. [C320]

"A visualization method of measuring the effectiveness of early warning and detection network based on simulation"

Computer simulations are often employed by operational research analysts to evaluate the relative effectiveness of various combinations of military equipment and tactics (i.e., options) for specific tasks within a conflict scenario. In order to value the effectiveness of Early Warning and Detection (EW&D) network, this article proposing a visualization method of Measuring the Effectiveness based on simulation. This method switches the problem into the task with clear military meaning, appraises the degree of completion of these missions respectively, and represents it visually. In this paper, the process of the evaluation based on simulation is discussed, in addition evaluation indictors and representative missions are presented. At last, we verify the method by analyzing an example briefly that proves the practicality of the method. [C321]

"Trajectory control of autonomous fixed-wing aircraft performing multiple target passive detection and tracking"

This paper presents progress made in a previously proposed algorithm for trajectory optimization of autonomous aerial vehicles performing multiple target tracking. The base algorithm, which was described in two earlier papers, involves a variant of the model predictive control approach, built on a partially observed Markov decision process (POMDP) model of the sensor-target system. In this paper modifications and additions made to deal with fixed-wing aircraft dynamics of the controlled vehicles are described and results of simulations involving multiple fixed-wing UAVs, no-fly zones and targets are presented. [C322]

"Discremination of adjacent radar targets via the E-pulse technique"

In all radar detection systems, the antenna system has resolution that is inversely proportional to the antenna beam-width. Even with a very narrow beam-width, the resolution decreases with the increase in the target height. The resolution is defined by the capability to discriminate between targets. In this paper, we propose the target identification scheme, the Extinction pulse "E-pulse", to discriminate between two targets that lie within the antenna main beam. In this paper, the discrimination procedure is tested using two adjacent cylinders illuminated by an incident plane wave with arbitrary incidence angle. The scattered field is calculated using the XFDTD software package. [C323]

"Study of efficient broadband beamforming based on extended towed array measurement"

In this paper, extended towed array measurement and broadband beamforming in frequency domain are combined together to form a new efficient broadband beamforming based on extended towed array measurement (ETAM-FCBF). The angular resolution of this method is higher than the conventional beamforming, and the detection ability of the weak target is more excellent. Moreover, this method is fast enough for real-time processing. [C324]

"GMTI tracking using signal strength information"

Signal strength information is a standard output of a modern radar system. Provided the amplitude of the target returns exceeds the false alarm background, the consideration of signal strength may lead to improved target estimates, depending on the scenario. In this paper a Bayesian tracking algorithm is presented which incorporates the signal strength information. In contrast to previous approaches, the knowledge on the target's signal strength is not only used for an improved calculation of the association probabilities, but it enters into the

algorithm as a random variable which is sequentially estimated. By this approach it is not only possible to discriminate closely-spaced targets and improve the track continuity, but also to support possible classification and identification tasks. The signal strength fluctuations of the target returns are modeled by the Swerling-I and Swerling-III cases. As a first performance evaluation, numerical results are presented based on a multi-target simulation scenario. [C325]

"System for optimizing mutliple-target identification methods"

Differential measurement methods with array of Doppler radars are used for an estimation of target trajectory. Passive and active methods give different approaches. This paper deals with a multiple-target identification algorithm and error evaluating system for multiple-target tracking. The evaluating system is primary aimed at testing of tracking algorithms but it is also able to involve other investigations of factors causing errors (PSD peak detection methods, error dependency on SNR, DTFT overlapping, window length and shape). Presented track identification algorithm is trying to estimate the physical behavior of the target by using gradient movement prediction and by defined limits for special causes. [C326]

"An above-water testing's result of experimental surveillance radar with 64-channels digital antenna array"

In this article are analyzed a results of experimental radar with digital antenna array full-scale test against above-water targets, small-boat detection and tracking. [C327]

"Net based waterside security applications: From small solutions to maritime security networks"

The protection of military harbours is a complex task. A force protection system integrates several sensors and databases for ashore and waterside surveillance: • passive sensors (acoustic, magnetic, CCTV, IR, FO fence) • active sensors (Radar, Diver Detection Sonar) • remote / autonomous vehicles for inspection and surveillance • chart database • information database Additionally a network-based waterside security application should integrate several additional sources and services e.g.: • WEB based Automatic Identification System (AIS) • Satellite based AIS • Access to online databases e.g. weather information, ship register data • C4I data e.g. MCCIS (NATO C4I system) or JoCIS (EADS export C4I system) Also, new technical possibilities of modern multi touch HMI approaches and aspects of user centric man machine interface design will be discussed. [C328]

"Concurrent use of satellite imaging and passive acoustics for maritime domain awareness"

The research being conducted in the Center for Secure and Resilient Maritime Commerce (CSR), a DHS National Center of Excellence for Port Security examines some basic science issues and emerging technologies to improve the security of ports and inland waterways, as well as coastal and offshore operations. This research follows a layered approach utilizing above water and underwater surveillance techniques. The investigated layers include satellite-based wide area surveillance; HF Radar systems providing over-the-horizon monitoring; and nearshore and harbor passive acoustic surveillance. Integration of these systems is aimed at achieving vessel detection, classification, identification, and tracking. In this paper, we present the results of sea tests where satellite imagery was combined with concurrent passive acoustic surveillance. The wide area sensing was provided by the University of Miami CSTARS facility's electro-optical (EO) and synthetic aperture radar (SAR) satellite imaging capabilities. Satellites detected the ships using a panchromatic EO sensor FormoSat-2 and SAR from the COSMO-SkyMed constellation. The Stevens Passive Acoustic System was used for detecting sound produced by the same ships that were detected by satellites. Concurrent Satellite-Acoustic measurements provide the following advantages: 1. Increasing the probability of small vessel detection and decreasing false alarms. 2. The joint systems can provide redundant detection and classification in conditions where one of the systems fails. For example, EO satellite imaging does not work at night and in fog and cloudy conditions while acoustic detection has limits during stormy weather due to ambient noise. SAR imaging can detect vessels in all weather, but provides less detail about a specific vessel. 3. Acoustics can provide target classification and bearing and satellites can give target localization and heading. SAR data can be used to estimate vessel speed in some cases. 4. Satelli--te imaging is helpful for the acoustic detection of an underwater target in cases when satellite information allows separation of surface and underwater targets. 5. Joint measurements provide more data (information) for target classification. Several tests were conducted in New York Harbor, where the satellite images and acoustic signatures of the same boats were recorded. The satellite registered a number of small boats. The small boats were acoustically detected at distances up to 4 km and the signal generated by a passenger ferry was observed at a distance up to 7 km. [C329]

"Application of AIS in Marine Search and Rescue Radar"

Nowadays marine radar detects targets by Constant False Alarm Rate (CFAR). But the search and rescue

efficiency is low in poor visibility or serious interference. In this paper, we reference learning mechanism, set up the AIS information for the sample and estimate the threshold t of the search targets with Maximum Likelihood (ML). Then any ship can be distinguished and searched. Experimental results show that using this method can improve the efficiency and accuracy of marine search and rescue radar searching the targets. [C330]

"Autonomous marine craft navigation: On the study of radar obstacle detection"

Technological advancements over the years have increased the use of Radar technology in the field of robotics, especially in marine robotics to aid obstacle detection algorithms. Obstacle detection comprises of an analytical process in which different algorithms are applied to the field of study to determine the range of objects that are within the reach of a robot. Radar signal analysis and target detection in conjunction with target tracking are attributes required for autonomous marine navigation. The paper presents a model which converts optimal estimates of radar range values for each range spectra into multiple targets down-range and also presents an approach for power range spectra (range bins) prediction using the radar range equation with adequate information of the signal-to-noise ratio (SNR) of the radar. Obstacle detection in the presence of noise raises certain probabilities of false alarms. Target characteristics are simulated and these are fluctuating targets and non fluctuating targets. Analytical models, simulations and techniques of obstacle detection for autonomous marine craft navigation using a continuous wave radar system were points of discussion in the paper. [C331]

"Multifunction array lidar network for intruder detection, tracking, and identification"

This paper describes a novel lidar sensor network based on a small, flat, optical phase array laser aperture. The network of array lidars provides collaborative automatic detection, tracking, acquisition cueing, and intruder type identification, as well as free space optics communication. The lidar consists of four optical phased arrays, each with about 1 million radiating elements in a 1-cm2aperture that enable electronic beam steering analogous to microwave array antennas. The four arrays are mounted on four sides of a stalk and have a full 360° field of view. A small number of such stalks can perform target detection over a large area. [C332]

"Search Aid System Based on Machine Vision and Its Visual Attention Model for Rescue Target Detection"

The prompt search and rescue of lifesaving target is very important in the case that a marine casualty occurs. To detect the small target in the wide views over the sea, we have proposed a machine vision system to aid search and rescue on the sea, which combines remote sensing, radar, infrared with visual light technology. One of the detection methods in this system, which is based on visual attention mechanism, is proposed in this paper to find rescue target from visual light image. The color information, image intensity and other image properties are used to generate the feature maps that form the saliency map subsequently with the weighted integrating strategy. The experimental results show that the proposed method is efficient to detect the small target in cluttered ocean scene. [C333]

"Estimating polynomial structures from radar data"

Situation awareness for vehicular safety and autonomy functions includes knowledge of the drivable area. This area is normally constrained between stationary road-side objects as guard-rails, curbs, ditches and vegetation. We consider these as extended objects modeled by polynomials along the road, and propose an algorithm to track each polynomial based on noisy range and bearing detections, typically from a radar. A straightforward Kalman filter formulation of the problem suffers from the errors-in-variables (EIV) problem in that the noise enters the system model. We propose an EIV modification of the Kalman filter and demonstrates its usefulness using radar data from public roads. [C334]

"A secured chaos encrypted mode-S aircraft identification friend or foe (IFF) system"

This paper introduces a new technique for aircraft identification friend or foe (IFF). The technique is based on using a proposed Chaos Advanced Encryption Standard (AES) with mode-S IFF. AES has a key size of 128 bits and a substitution-linear transformation network with 10 rounds. The sensitivity of the chaos initial condition gives the algorithm the ability to use as a second key. The first key was assigned using a soft look-up table used periodically. The second key was assigned using the date of the current day by both interrogator and the transponder. This technique gives the system more security and confidentiality which is compatible with mode-S IFF interrogation and reply messages format. It requests a new data on the reply signal. This data increase the radar performance for detection and tracking the friend targets in active and passive jamming environments. The results obtained from this technique on the simulated interrogator and transponder signals shows that this scheme can be easily implemented and provide the air defence system a secured aircraft authentication. [C335]

"UWB Microwave Monopulse Radar System for breast cancer detection"

The concept of an Ultra Wideband (UWB) Monopulse Microwave Radar System for detection and location of breast cancer is described. The system uses a two-element Tapered Slot Antenna (TSA) array accompanied by a UWB 180° hybrid which scans the breast. When the breast tissue features symmetry with respect to the array axis and the hybrid enables the 180° out phase feeding operation, the array automatically eliminates background while extracting information about an off axis target. The data obtained from the scan is post-processed using a novel imaging algorithm to locate the target. The design of the required 2-element UWB array antenna and the 180° hybrid is presented. The validity of the proposed breast cancer detection method is demonstrated in an example of a simple breast phantom formed by a cylindrical plastic container filled with a vegetable oil and small cylindrical targets. [C336]

"Design of mine detection robot for Korean mine field"

This paper presents the critical design constraints of mine detection robots for Korean minefield. As a part of a demining robot development project, the environment of Korean minefield was investigated, and the requirements for suitable robot design were determined. Most of landmines in Korean minefield were buried close to the demilitarized zone (DMZ) more than half of a century ago. The areas have not been urbanized at all since the Korea War, and the potential locations of the explosives by military tactics have been covered by vegetation. Therefore, at the initial stage of the demining robot system development, the target areas were investigated and the suitable design for Korean minefield terrain was determined. The design includes a track type main platform with a simple moving arm and a mine detection sensor (consists of a metal detector and a GPR at this stage). In addition, in order to maintain the effective distance between the landmine sensors and ground surface, a distance sensing technique for terrain adaptability was developed and briefly introduced in this paper. The overall design of this robot was determined by considering the speed of the whole mine detection process and a point of economic view to replace human in minefield. Thus, the detail of the conceptual design and the mine detection scenario is presented in this paper. [C337]

"Singularity detection of TWR echoes based on correlation"

This paper introduces a modified algorithm of singularity detection based on modulus maxima for through-wall radar (TWR) targets detection. By tracking the wavelet transform modulus maxima (WTMM) at fine scales, singularities can be detected, and the important information of human target is also selected. According to the singularities of TWR A-scan signal, it can be commendably given prominence to the targets. Finally, singularity detection based on modulus maxima was successfully realized. [C338]

"Method to determine CPI for ubiquitous radar"

Ubiquitous radio: is a new radar system that provides continuous and uninterrupted multifunction capability within a coverage volume. Continuous coverage from close-in "pop-up" targets in clutter to long-range targets impacts selection of waveform parameters. The CPI (Coherent Processing Interval) must be long enough to achieve a certain signal-to-noise ratio (SNR) that insures the efficiency of detection. This paper analyzes the condition of detection in the case of low SNR, discusses three different cases that would occur during integration and presents a method to determine the CPI. The simulation results show that it is available to determine the CPI for targets detection with SNR as low as -26dB in the experimental system. [C339]

"New target detection method in strong active jamming background for polarimetric radar"

A new method of target detection for polarimetric radar in the presence of strong active jamming is proposed. Based on analysis of the polarization characterizations of the signals received by polarimetric radar, the target detection is achieved through testing on the polarization information. Comparing with the traditional method of target detection made in time-frequency domain, the detection performance of the new method is improved because the influence of the strong active jamming is avoided. The performance of the new method is analyzed by simulation. Its validity is verified through outdoor experiment carried out by X-band polarimetric radar. [C340]

"Time delay and doppler shift estimation accuracy analyses of moving targets in non-cooperative bistatic pulse radar"

According to the characteristics of non-cooperative bistatic pulse radar systems and the issue that the doppler mismatched loss of the cross-correlation detection of moving targets is serious, two fast methods for joint time delay and doppler shift estimation of moving targets, based on segment correlation-FFT processing and modified partial segment correlation-FFT processing, are proposed, after analyzing the common methods for cross-ambiguity function processing such as direct calculation, FFT, Zoom-FFT method. The processing performance

of direct calculation and partial segment correlation-FFT processing of LFM pulse-series is analyzed in theory and by simulation. And the simulation shows that the weak moving target can be detected effectively and the time delay and doppler shift can be fast estimated by the methods presented in this paper. [C341]

"Overlaying orthogonal coding for sidelobe suppression in HFSW radar"

Strong sidelobes not only lead to false alarm, but also affected the target detection. By overlaying an orthogonal coding over any analog or digital signal, we can completely remove most of the ACF (auto correlation function) sidelobes without any increase to the mainlobe sidelobes. In this paper, we discuss how to choose the original signal for HFSW radar and give the affection of different overlaying matrix. [C342]

"A new method of denoising processing for synthetic aperture radar return signal"

In this paper, a denoising processing method for synthetic aperture radar raw return signal is proposed based on the DFT-DWT transform. Compared with presented transforms of DFT and DWT, the DFT-DWT transform is more efficient to extract the SAR raw return signal which is a complex 2-D signal with different properties between the two directions. After removing the out-ofband and high-frequency part of the SAR return signal's DFT-DWT transform, the noise can be eliminated efficiently. Experimental results verify that the SAR denoising processing method has a practical value for suppressing the suppression jamming and detecting the weak targets. [C343]

"A mover detection method based on 2-D fuzzy entropy in SAR images"

In this paper, a new technique for the moving targets detection combining incoherent and coherent information of the Synthetic Aperture Radar (SAR) images is proposed based on the measure of a two-dimensional (2-D) fuzzy entropy principle. Firstly, it extracts incoherent and coherent information from images in pixel and builds a 2-D histogram. Secondly, according to 2-D fuzzy function, image pixels are fuzzy classified into two groups: changed and unchanged then 2-D fuzzy entropy is calculated. Finally, Differential Evolution (DE) algorithm is used to maximize the entropy and the optimal parameters of the fuzzy function are obtained, which procures effective moving target detection results. [C344]

"Target detection with distributed radar sensor networking systems (DRASENS)"

An innovative radar sensor networking system is introduced for effective target detection. By using orthogonal coding waveforms, the number of radar echoes generated by the radar network from the same target is maximized for the best fusion processing result. Several centralized signal detection schemes are investigated for the networking system and their performances are evaluated. [C345]

"Parameters estimation of target with precession based on combined feature"

It is beneficial for the recognition and classification of targets to obtain geometrical and motional parameters simultaneously. This paper proposes a new method to estimate parameters of target with precession based on combined feature, which is generated by Doppler feature and high range resolution feature of target from a new radar-OFDM radar. Expanded Hough transform (EHT) is employed to establish the combined feature with range and motion information of scatterers. The paper mainly presents the principle to establish the combined feature and the estimation of precession angle, target posture and target length. Finally, the results from simulations and anechoic chamber data prove the validity of the method. [C346]

"Radar track-before-detect algorithm of dim target based on track test"

This paper proposes a track test-based track-before-detect algorithm for radar target detection. Track test is used to estimate the target motion model. The implementation of this scheme on the search tracks and the detection strategy on the energy accumulation values of tested tracks are presented. Simulation results show the proposed algorithm have better detection performance and tracking performance, compared with the dynamic programming-based track-before-detect algorithm. [C347]

"Detection of moving target based on fractional Fourier transform in SAR clutter"

Based on the analysis of the characteristics of SAR target echo and the time excursion of fractional Fourier transform (FRFT), the Article has put forward a time-delay balance method based on FRFT to detect the slowly moving target in SAR echo according to the characteristics of SAR ground clutter. Calculation on the FRFT of echo signal and the FRFT of echo signal after short delay time results in two complex signals, in which, the modules of static backgrounds are just totally same, and in the range of moving target, the amplitude of module

will cause an offset, therefore, when calculate the difference of the modules of two complex signals, the static background could be balanced and the moving target could be detected effectively. Simulation analysis indicates that the method in the Article shows its advantages in a background with strong clutter. [C348]

"Adaptive clutter map detector in nonhomogeneous environment"

The Ordered Data Variability (ODV) technique is introduced into hybrid clutter map/L-CFAR technique, which is used to process the echoes on the clutter map spatially. The new method is called as Clutter Map/ODV (CM/ODV) technique. An analytic expression of detection probability in homogeneous environment is presented, and detection performance in three different situations in nonhomogeneous environment is analyzed. The CM/ODV can censor interfering targets adaptively and prevent the masking effect, moreover, it doesn't need any priori information, so the new kind of clutter map technique performs robustly. [C349]

"A novel approach of countering centroid jamming by using INS information in terminal guidance"

During anti-ship missile (ASM) tracking ship in terminal guidance phase, echo in monopulse radar seeker receiver was generated by modeling chaff and ship as Swerling II and Swerling IV in chaff centroid jamming scenario, respectively. A generalized likelihood ratio test (GLRT) algorithm was then proposed for chaff detection in the main-beam. When the presence of the jamming was detected, one can combine target position forecast with inertial navigation system (INS) navigation solution to accomplish the homing guidance of ASM, and then when the absence of the jamming was detected, radar seeker capture and track target again, which could help achieve one's purpose of anti-jamming. Simulation showed that this method was effective and feasible due to its preferable anti-jamming performance. [C350]

"A TBD algorithm based on dynamic-programming for dim radar target detection"

When the received echo signal energy reflected from a target is quite small, the target cannot be detected reliably with traditional accumulation and detection method. In this paper, based on the stable factor, an improved method is proposed, which utilizes the difference of correlation characteristics between clutter and target to suppress clutter spike. Then the track-before-detect algorithm based on dynamic-programming is applied to dim radar target detection. Compared with the combination method of coherent and non-coherent integration, the predominance of the algorithm is obtained on dim radar target detection. [C351]

"Track clustering based data association for sky-wave Over-the-horizon Radar"

The multipath propagation and low measurement precision in sky-wave Over-the-horizon Radar (OTHR) pose new challenges to data association. Aiming at the formation of ships, this paper presents a new method of data association. Firstly the plane measurement model is established, and the transformation between radar and ground coordinates is deduced according to the given ionospheres state, which leads to different propagation modes. Then measurements observed from radar are transformed to ground coordinates considering all possible propagation modes, and the transformed points in ground coordinates for each measurement are called hypothetic points. Max-min distance clustering method is adopted to divide these hypothetic points into multi-classes. The feasible classes are selected using the restriction of propagation modes, and the geometry center of clustering can be calculated by averaging the points of feasible class. Finally, the nearest neighbor method is used to associate the geometry centers of clustering among different scans and further find the correlation of measurements, propagation modes and targets. Simulation results indicate that the proposed algorithm can associate the tracks in the formation of ships effectively, and the influence of radar detection probability on the algorithm is also analyzed. [C352]

"Target detection with MSN algorithm for the bistatic radar using digital broadcasting signals"

In the bistatic radar, it is important to suppress the undesired signals such as the direct propagated signal from transmitter and its multipath components. Conventionally, the suppression method by subtracting the replicas of the undesired signals is often used. However, it requires the precise delay times of the undesired signals. In this paper we propose a new method to detect the target without any information on the undesired signals' delay times in digital terrestrial TV-based bistatic radar, the signal of which is based on orthogonal frequency division multiplexing(OFDM). This kind of the radar is called "passive bistatic radar." We adapt a scheme based on maximum signal to noise ratio(MSN) algorithm, which makes signal to interference plus noise ratio(SINR) maximum for the certain delay component. The maximum sensitivity is steered along the delay which relates to the target position, as if the search beam is steered along the direction in array signal processing. The sensitivity is steered by the weight applied to the received signal in the frequency domain. We obtain the method to estimate the weight to achieve the maximum SINR in the delay estimation which also includes the compensation for the reduction of the weight's length caused by decorrelation among the delay components. The simulation

results show our proposed method without any information on the undesired signal's delays provides the sufficient performance compared to the conventional one. [C353]

"MIMO radar with spatial-frequency diversity for improved detection performance"

The Multiple Input Multiple Output (MIMO) radar concept exploits the independence between signals at the array elements unlike beamforming which presumes a high correlation between signals either transmitted or received by an array. Radar Cross Section (RCS) of a complex target varies with both transmitted frequency and target geometry. By widely separating transmit and receive antennas, MIMO radar systems observe a target simultaneously from different aspects resulting in spatial diversity, thus improving the detection performance. Also by utilizing different frequencies, independent RCS of the target can be observed, thus resulting in frequency diversity. In this paper, the spatial and the frequency diversities are studied together to bring out the combined benefits. The system proposed will not only have several antennas appropriately spaced but also several operating frequencies appropriately spaced, providing a better detection performance than conventional MIMO radar systems for the same transmission power. The simulation results exhibit a better detection performance of the proposed system as compared to MIMO radar systems with only spatial diversity. [C354]

"Range tracking filter using measurements with uncertain delays"

In modern marine range tracking systems, both Doppler radar and range sensors are often used to enhance the detection and tracking performance against sea clutters. Due to the delays in communication links, however, the measurements of the sensors do not arrive simultaneously to the data processor where the tracking filter operates. Moreover, the magnitudes of the delays vary irregularly. To cope with this problem of uncertain time delays, in this paper, we propose a new range tracking filter algorithm by adding a ZSB (zero-scan-back) MAP (maximum a posteriori) delay estimator to conventional Kalman tracking filter. Computer simulations are carried out to demonstrate the performance of the proposed filter. [C355]

"An algorithm for detecting a maneuvering target based on TFR and Viterbi algorithm"

An algorithm for radar signal detection method based on a time-frequency representation (TFR) and Viterbi algorithm (VA) is proposed. Two TFR methods are considered, Short-time Fourier Transform (STFT) and S-method (SM). Performance and detection ability of the proposed algorithm was investigated on real radar signals of a single manuvering target with added Gaussian noise and signal-to-noise ratio from -15 dB to -2 dB. The results show that the proposed algorithm works well even in very low SNR values. [C356]

"The Adaptive Detector of MIMO Radar and Its Performance"

Aiming at that the echo signal lies on the target characteristic in target detection of MIMO radar, namely the RCS of target determines the echo intensity, MIMO radar adaptive detector is based on the GLRT MIMO radar. It samplings in the radar receiver, makes the test be related to the SNR and sample size, and overcomes that the amplitude of echo effect detector's performance. then The better detector is achieved. The relative entropy, which is used to test the detection performance can represent the effect of the sample size on the detection performance. It is proved by the entropy that the MIMO detector is feasible and advanced. [C357]

"Track-Before-Detect Based on Two-Stage Sampling Particle Filter"

A modified track-before-detect based on two-stage sampling particle filter is proposed for detection and tracking of a target with low signal-to-noise ratio in an image sequence. According to each component's impacting on measurement directly or not, the state vector is partitioned into two parts. Then a higher-dimensional sampling problem in TBD can be changed into two successive lower-dimensional sampling problems. This improves the efficiency of state sampling. Results on simulated data show a higher gain in performance of detection and tracking. [C358]

"Intelligent Processing Research for Target Fusion Recognition System Based on Multi-Agents"

According to the target fusion recognition under dynamic and uncertain target information conditions, a distributed target fusion recognition model is presented based on multi-agents. As a distributed multi-agents target recognition system, the model includes several widely distributed agent workgroups. The model is mainly made up of the detection agent, the recognition agent and the decision-making agent. The detection agent mainly realizes characteristics matching and sensor conditions controlling, the recognition agent is composed of information fusion algorithms into the nesting agents, the decision-making agent carries out various decision-making and cooperation mechanism. Then, the intelligent fusion processing under dynamic and uncertain environment is realized through communication and cooperation of the three agents for the actual condition

request. It combines MAS and information fusion technology in target recognition system, and incarnates the advantages such as flexibility, reliability. Finally, by analyzing a ballistic target recognition experiment, the result is shown the model efficiency is advanced by the means. [C359]

"Frequency diversity for active sonar/radar application and optimal receiver design"

MIMO (Multiple Input Multiple Output) concept has been explored for radar/sonar application recently for improving target detection and estimation performance. The existing work in this direction mainly investigates the spatial diversity and waveform designs based on the assumption of the same carrier frequency for multiple transmitters. In this work, we investigate the frequency diversity by using multiple narrowband transmitters of different center frequencies. We prove that the ambiguity function for such signal is not an optimal receiver, and propose an optimal receiver for signals with different frequency components. [C360]

"A Novel Algorithm of Velocity Ambiguity Resolution for Wind Profiling Radar"

Wind Profiling Radar can be used to detect the distribution of atmospheric three-dimensional wind, the quality of velocity information affects its performance directly. Compares to other weather radar, wind profiling radar's velocity ambiguity is particularly prominent when used to detect signal. Multiple PRF (pulse repeat frequency) is often used in radar system in order to solve the ambiguity problem. In this way, radar system has a variety of solutions for ambiguity algorithm in signal processing. In this paper, Doppler frequency series (DFS) algorithm can recover target's true velocity from the coupling velocity estimating directly. Simulation results proved the effectiveness of the method, and show us the DFS algorithm for speed estimation performance. Finally, optimization of one-dimensional set of algorithms-compare screening algorithm and DFS algorithm to ambiguity-resolving, given the speed estimated in the DFS algorithm superiority. [C361]

"Mean shift track initiation algorithm based on Hough transform"

To solve the problem of initiating tracks for multi-target in dense clutters environment, a Mean shift track initiation algorithm based on Hough transform is proposed. In the algorithm, firstly, hough transform is applied to transform observation points from input space, referred to as feature space into curves in a special parameter space; then a Mean shift clustering algorithm is executed to cluster the items gained in the parameter space, and the problem of peak seeking is also solved adaptively. Furthermore, a fuzzy influential factor, which is based on the vote number of accumulation matrix and distance between items in the parameter space and clustering center, is defined to design kernel function of Mean shift; thus clutters are removed more effectively. Experimental results show that proposed algorithm has high detection accuracy and can initiate tracks effectively. [C362]

"Compact microstrip antenna design for microwave imaging"

An ultra-wideband microstrip antenna design is considered with respect to applications in breast cancer detection. The underlying design concept is based on ground penetrating radar (GPR). Simulated and measured prototype performance show excellent performance in the input impedance and radiation pattern over the target range from 4 GHz to 8 GHz. The 4 GHz to 8GHz frequency band for microwave imaging perform better in comparison with other microwave frequencies. The antenna also shows a reasonable uniform radiation performance in the broadside direction which contributes to the reduction of clutter levels, thus aiding the reconstruction quality of the final image. [C363]

"On performance enhancement of a following tracker using stereo vision"

A stereo vision system has a distinctive advantage capable of obtaining exact and wide range of the distance information. The use of stereo vision system has been increased due to the advances in hardware technology. This paper deals with design of the active vision system which acquires the distance and the direction information of the target using the stereo vision system. This paper also implements the tracker that follows the main tracker, which we call a following tracker, without identifying the target. In addition, the CAMShift algorithm which tracks the target based on the color information is used to acquire the center point of the object. A following tracker algorithm generates the control input that makes the following tracker aim the same target based on the sensing results from the active vision system. A following tracker needs the exact distance information between the system and the target to track the object accurately. We first build the mathematical model of object tracking system and following tracker, design the system controllers, and then compare the tracking accuracy under the two conditions: the presence and the absence of the distant information. [C364]

"Study on the Signal Detection Algorithm of Weak Laser Radar Target Based on Wavelet

Transform"

According to the different transmission characteristics under the wavelet transform(WT) domain and the different distribution characteristics of frequency domain of the signal and noise, a novel approach for detecting weak signal laser radar target based on wavelet transform has been proposed. In many cases, wavelet decomposition has been used to de-noise a digital signal submerged by mass noise. Differently in our approach, we applied the wavelet decomposition and the modulus maximum to detect the locations of laser radar echo signal. Simulation shows that the proposed algorithm is more efficient than only utilizing wavelet decomposition in a clutter environment. [C365]

"Modeling of 3D pencil beam radar (PBR) volume coverage and 3D DMC"

The actual three dimensional radar purposes are to detect the target in three dimensions range, height and azimuth angle. The objective target for this paper is to simulate and study the three dimensional 3 D radar pencil volume coverage and the evaluation of the 3 D detection map contours (DMC) in complex environment. Also, the 3D DMC and 3D volume coverage are examined for different polarizations, such as horizontal, vertical, and circular. The results show that greater DMC and volume coverage are obtained in case of using horizontal polarization than the vertical and circular polarizations, also the vertical polarization produces greater ranges and greater DMC than the circular polarization assuming that the same radar parameters and same environment for the two cases, the free space and interference conditions. Also the accuracy measurements for the elevation and azimuth angles are better when using the Pencil beam coverage. The applications of the 3D (PBR) are widely used and interested for ATC radars and the EWR for homeland defense and protection because they are offering the prediction of radar performance and radar sitting. The detection and tracking facilities are obtained simultaneously which improve the target processing time and minimizing the cost. [C366]

"Tracking a minimum bounding rectangle based on extreme value theory"

In this paper, a novel Bayesian estimator for the minimum bounding axis-aligned rectangle of a point set based on noisy measurements is derived. Each given measurement stems from an unknown point and is corrupted with additive Gaussian noise. Extreme value theory is applied in order to derive a linear measurement equation for the problem. The new estimator is applied to the problem of group target and extended object tracking. Instead of estimating each single group member or point feature explicitly, the basic idea is to track a summarizing shape, namely the minimum bounding rectangle, of the group. Simulation results demonstrate the feasibility of the estimator. [C367]

"Radar waveform design for detection of weapons"

We present waveform design based on signature exploitation techniques for improved detection of weapons in urban sensing applications. We consider a single-antenna monostatic radar system. Under the assumption of exact knowledge of the target orientation and, hence, known impulse response, matched illumination approach is used for optimal target detection. For the case of unknown target orientation, we propose waveform design based on subspace decomposition of the target impulse response matrix corresponding to the various aspect angles. Numerical electromagnetic modeling is used to provide the impulse responses of an AK-47 assault rifle for various target aspect angles relative to the radar. Simulation results depict an improvement in the signal-to-noise-ratio (SNR) at the output of the matched filter receiver for both matched illumination and subspace waveforms as compared to a chirp waveform of the same duration and energy. [C368]

"Vessel detection and classification: An integrated maritime surveillance system in the Tyrrhenian sea"

In recent years a number of organizations, both national and international, have put significant efforts in developing knowledge-based integrated maritime surveillance (IMS) systems. The final aim is to have a clear picture of the position, classification, identification and movement of cooperative and non-cooperative targets entering and leaving the 200 nautical miles limit of the Exclusive Economic Zone (EEZ). Each sensor (i.e. satellite-based, ground-based, shipborne or airborne) has its own task and, in such a context, high frequency (HF) surface wave (SW) radars are inexpensive tools for long range early warning applications in open waters. They allow maximizing the effectiveness in dealing with fisheries protection, drug interdiction, illegal immigration, terrorist threats, search and rescue tasks. This paper focuses on the possibility of combining automatic identification system (AIS) data with HFSWR data for vessel detection and classification purposes. Three algorithms for target detection in compound Gaussian HF sea clutter are presented and their performance evaluated. The combined use of AIS plots provided by cooperative targets can allow the operator to discriminate non-cooperative targets and possible threats. The concurrent exploitation of AIS and HFSWR data is presented and discussed by means of real data recorded during the NURC experiment in the northern Tyrrhenian Sea in

May 2009. [C369]

"Utilizing ISAR imagery to analyze the diffraction effects from leading and trailing edges of a target"

In this work, we analyze the effect of leading and trailing edge diffractions on two-dimensional (2-D) inverse synthetic aperture radar (ISAR) imaging of a complex target. The well-known shooting-bouncing ray (SBR) method combined with physical theory of diffraction (PTD) technique is employed to estimate the far-field scattered electric field from the target as a whole. The PTD method used in this paper to calculate a diffraction contribution for each ray hits the platform's surface vicinity of an edge. To show the effect of leading and trailing edge diffractions on 2-D ISAR images, first, a wing like test model and then a large complex platform are considered. It is demonstrated that the diffraction phenomena from the leading or the trailing edge becomes more distinctive on 2-D ISAR images if an appropriate polarization and illumination condition for the related edge is provided. [C370]

"A recursive model for partially correlated χ2 targets"

This work considers the problem of χ2target detection in normal (Gaussian) noise. The single pulse power, and target RCS, are χ2distributed with an arbitrary form factor k. The correlation between pulses is determined by target dynamics, according to a simple rule of thumb. The sequence of target pulses is constructed using a recursive model of Markov chain, and the value of the correlation coefficient is derived. An approximation of 'strict sense χ2' is assumed for the probability density function (p.d.f) of the sum of the integrated pulses. The form factor K of this density is calculated in terms of the correlation coefficient, number of integrated pulses and the form factor for the single pulse p.d.f-k. By determination of the normalized threshold for the given Pfa(probability of false alarm), the probability of detection-Pdcan be obtained. One way to do these calculations is using the "universal detection equation" suggested by D.K Barton (7.2005). The model can be used in radar system performance analysis and in simulations. The advantage of these methods is the elimination of the use of tables and graphs, and enabling direct computations such as in multiple situation simulations. It can be done using commercially available advanced mathematical software. [C371]

"Model based adaptive detection algorithm with low secondary data support"

In this paper the problem of adaptive target detection in structured Gaussian clutter is considered. The clutter is modeled as an auto-regressive process with known order but unknown parameters. To solve this problem, we have modified a well known adaptive detector (Kelly's GLRT) in four different forms. In this detector an estimation of covariance matrix is needed. In order to estimate the covariance matrix, we estimate the AR parameters based on secondary data and use the results in covariance matrix estimation. Then, we use the estimated matrix in the detector structure. In order to estimate the AR parameters using more than one set of data, we have extended four classical AR parameter estimation techniques to use more data sets. The performance of the proposed detectors have been evaluated using Monte-Carlo simulations and compared with each other. [C372]

"Generalization of Automatic Censored Mean Level Detector (ACMLD) for MIMO radars"

Constant False Alarm Rate (CFAR) processors are useful for detecting radar targets in background for which all parameters in the statistical distribution are not known and may be nonstationary. Many CFAR techniques have been proposed for conventional radars in nonhomogeneous background. One of the most robust CFAR detectors in multiple target situations is Automatic Censored Mean Level Detector (ACMLD) which does not require any prior knowledge about the number of interfering targets. In this paper, ACMLD algorithm is generalized for Multiple Input-Multiple Output (MIMO) radar. An exact expression for the false alarm probability of the proposed algorithm (M-ACMLD) is presented. Then, the performance analysis of M-ACMLD is studied in both homogeneous environment and multiple target situations. [C373]

"Simultaneous detection and tracking of multiple objects in noisy and cluttered environment using maximum likelihood estimation framework"

We discuss a versatile framework for multiple target detection and tracking based on maximum likelihood estimation with expectation maximization and a cognitive theory called dynamic logic. In this contribution extend the framework to detection of moving objects in video sequences. The paper presents the theory and an example of detection and tracking using a real world video sequence. [C374]

"A progressive approach for building extraction by fusing LIDAR data and co-registered bands"

In this paper, a progressive approach is presented for building extraction from LIDAR combined with its co-

registered bands. Carefully tuned Gabor wavelet filters are applied to LIDAR data for object detection on the earth, and to localize targeted objects in order to minimize hilly terrain effects. Object classification is then carried out in local areas where objects exist. The Dempster-Shafer (DS) theory of evidence is used to conduct initial classification by fusing LIDAR and its co-registered data sets; and a fuzzy Markov random field (FMRF) model takes the output from the DS theory of evidence, and is performed the further object classification to extract buildings. Finally the level set approach is employed for building boundary extraction. The testing experiments under this research have shown the potential of this approach in accurately extracting buildings from airborne LIDAR and its co-registered bands. [C375]

"Maximum likelihood estimation of target RCS in tracking"

In this paper, a maximum likelihood (ML) approach is presented for estimating the average radar cross section (RCS), and a numerical solution to the approach is proposed based on a generalized expectation maximization (GEM) algorithm. Estimation accuracy of the approach is compared to that of a previously reported procedure. [C376]

"Coherent change detection with complex logarithm transformation on SAR imagery"

A satellite-borne SAR (synthetic aperture radar) is quite promising technique for high-resolution geosurface measurement. Recently, the feature extraction method based on the CCD (coherent change detection) has been developed, which detects a small surface change on the geosurface by using the phase relationship between the plural complex SAR images of the same region in different observations. Aiming at fast and accurate detection of the surface change, the logarithm transformation method, has been proposed. This method can determine the appropriate threshold for the change detection, while enhancing the detection probability and suppressing the false alarm rate. However, it does not employ phase information of the estimated coherence function, and its detection probability deteriorates, especially in the case when target has small surface changes. To overcome this problem, a novel transformation index is proposed considering the phase difference of the coherence function. The results from the experiment modeling of geosurface measurement verify the effectiveness of the proposed method, even in the lower SNR (signal to noise ratio) situations. [C377]

"Impact of flight trajectory on the detection and selection of flowers by nectar-feeding bats"

Echolocating mammals, such as bats, have evolved an excellent ability to detect, select and identify the targets they depend on for their survival by echolocation even in the most challenging environments. They simultaneously adapt their trajectory and diversify transmission parameters such as waveform, bandwidth and time duration, to obtain high level detection and classification performance that is far better than that obtained by modern radar and sonar systems. This paper exploits the information available to the bat along its in-flight trajectory aiming at assessing the impact of choosing the right trajectory on detection and classification performance. A set of experimental data consisting of HRRPs of one inflorescence of Rhytidophyllum auriculatum is analysed and results are discussed and related to the case of radar and sonar systems. [C378]

"Rapid waveform adaptation for nearly optimal detection in colored interference"

A cognitive radar can dynamically design its transmit waveform in response to changing environmental knowledge, which may be obtained a priori, estimated online, or both. We consider the detection of targets in wide-sense stationary additive colored Gaussian noise. Cognitive radar has been shown to provide potentially significant improvements for this problem. However, existing algorithms may be too computationally demanding for some scenarios. We present an approach that can be implemented in the most demanding scenarios. This approach trades optimality for reduced computational complexity by computing a large library of nearly optimal waveforms before operation, and retrieving them rapidly at runtime. [C379]

"Sonar waveform design for optimum target detection: The impact of object burial state"

The design of transmit waveforms in sonar and radar that optimize the probability of detection of a known target is an area of active interest. Previous research has demonstrated the benefits of optimal transmit waveforms for enhanced target detection, versus the transmission of more conventional waveforms such as broadband LFM pulses. For maximum benefit, the scattering function or frequency response of the target to be detected must be known, along with the spectral or statistical properties of the environment. In this paper, we examine the impact of a mismatch between the expected frequency response of the target, for which the optimal transmit waveform was designed, and the actual frequency response of the target. In particular, we design the optimal sonar transmit waveform based on the free-field response of the target, and then examine the effects on detection performance of burial of the target in sediment. Simulations of the sonar backscatter from a steel sphere in the water column and at various stages of burial demonstrate that the impact of mismatch becomes increasingly

detrimental as the target becomes increasingly buried. For fully buried targets, the impact is such that transmitting a simple broadband LFM pulse can yield improved detection relative to "optimal" waveform design wherein there is a mismatch between the expected (free-field) and actual (buried) frequency response of the target. [C380]

"A Migrating Target Indicator for wideband radar"

The standard way to suppress clutter in narrowband radar is to use Moving Target Indicator (MTI) cancellation techniques. High Range Resolution (HRR) radars are becoming more and more important because they can detect and track targets more accurately. As for such radars the bandwidth is increased, the resolution is decreased and leads to target range migration over the coherent pulse interval (CPI). Due to this range walk, standard low resolution MTI processing is not adapted anymore to HRR MTI radar data. We propose here to extend the principle of the MTI processing to the wideband case. We refer to this method as the Migrating Target Indicator (MiTI), since it eliminates the non-migrating targets from the received signals. [C381]

"MIMO radars or is it smart antennas?"

Radars were originally designed as detectors of targets. The goal was to transmit a signal with the maximum available power and then observe whether the received signal contained a portion of the transmitted signal. A matched filter was then designed using the transmitted waveform to detect the received signal and based on some statistical hypothesis testing a decision was made on whether a target is present or absent. However, when multiple targets are to be examined or one wants to search for a low observable near a large target, the conventional detection based radar processing is not adequate. A need for finding small targets in the presence of clutter and jammer evolved into an estimation theory problem rather than detection. It is illustrated that use of a phased array in a SIMO mode can perform quite well as one does not have to worry about the inhomogenity of the clutter associated with multiple transmissions in a MIMO system as the processing becomes quite complicated. Also, the compensation of mutual coupling becomes difficult in a practical deployment on a moving platform. It is important to note that one can still exploit the advantages of super-resolution processing using estimation theory keeping the advantages of a single high power transmitting antenna in a phased array deployment. This paper illustrates such a methodology which has been in the published literature for at least a decade and compares it with the recent MIMO developments. Examples are presented related to a single snapshot based least squares methodology that can cancel interferer in the main beam using a phased array radar but performing a deterministic processing using the same number of degrees of freedom as a multisnapshot case for coherent processing. [C382]

"Estimation of soil permittivity through autoregressive modeling of time-domain ground-penetrating radar data"

Recent advances in context-dependent processing for vehicle-based route clearance suggest that information regarding the environmental context associated with ground-penetrating radar (GPR) data can potentially be exploited to improve target detection performance. In this work, a statistical approach to estimating soil permittivity (dielectric constant) from raw time-domain data is presented as an alternative to electromagnetic model inversion. First, a large set of GPR data was simulated using finite-difference time-domain (FDTD) modeling over a heterogeneous subsurface with a rough air/ground interface. Physics-based features were then extracted from the simulated data through autoregressive (AR) modeling of B-scan time slices. A linear least-squares regression model was applied to the features, and experimental results indicate that the dielectric constant of the base soil can be accurately predicted by the regression model. This approach has several advantages over model inversion techniques for estimating soil permittivity, since it is causal, computationally efficient, and does not require an analytical electromagnetic model a priori. [C383]

"ALARIC Forward-Looking Ground Penetrating Radar system with standoff capability"

The use of low-frequency, ultra-wideband (UWB) radar technology to help detect concealed or buried targets has been demonstrated in the past, and could provide an important capability for combat systems on the battlefield. As part of Army's mission and technical objective, the Night Vision and Electronic Sensors Directorate, Countermine Division has designed and developed a Forward-Looking Ground-Penetrating Radar (FLGPR) with standoff capability. The forward-looking GPR is an impulse-based radar system with a bandwidth that spans between 300-3000 MHz. The innovative design uses commercially available, off-the shelf (COTS) components to create an effective sampling scheme of approximately 8 GHz. The design is modular, and can be scaled to provide a means for future improvement of electronic components to eventually meet the requirements of various combat systems. Early results from recent tests suggest that metallic targets buried near the surface can be detected with this radar system. [C384]

"Adaptive filtering and target detection for ultrasonic backscattered signal"

In radar, sonar, medical ultrasound, and ultrasonic nondestructive evaluation, environmental noise makes target detection challenging. Therefore, clutter rejection and noise cancellation are necessary for the system to correctly identify targets. In this study, an adaptive filtering algorithm is used to reject clutter and detect small targets in noisy ultrasonic backscattered signals. Simulation and experimental results show that adaptive filter can efficiently reduce the clutter and improve the detection capability. [C385]

"Analog beamspace super-resolution radar processing"

Current monopulse radar does not resolve multiple sources within the main beam, a scenario that arises in a number of radar applications such as ballistic missile defense, where the incoming missile complex consists of a large number of objects; air defense, where a detection may correspond to a single plane or multiple planes; cruise missile defense for low angle target tracking in multipath; etc. This paper describes a superresolution technique designed for radar applications requiring resolving multiple targets within the main beam given a single snapshot of multiple beam data. The technique enables the practical implementation of such super-resolution algorithm by first forming multiple beams in the analog domain to provide data and degree-of-freedom (DOF) reductions without significant loss of information. Super-resolution is then achieved through the use of matrix processing techniques operating on the digitized beamspace data. The overall procedure can be considered a generalization of the monopulse processing scheme to the multi-target case. [C386]

"Efficient beam scanning, energy allocation, and time allocation for search and detection"

Recently-developed unique and innovative concepts for efficient radar search and detection are reviewed. These results provide answers to the two fundamental search questions: (1) Where should the radar beam point during the next increment of search effort (energy and time)? (2) How much radar effort should be expended during the next increment of search effort? These results provide the most efficient allocation of radar search effort in both space and time which maximizes target detection performance and minimizes radar search energy and time. Typical savings of several dB of radar power-aperture product and/or expected (average) detection time are obtained. These new techniques are practical and can be used in the next generation of radars with agile beams and variable-energy search waveforms. Furthermore, the problem formulation and solution are very general, so these search and detection techniques developed for radar can also be applied to other both active (transmitting and receiving) and passive (receive only) electronic sensors: optical, IR, UV, sonar, seismic, passive RF, astronomy, etc. [C387]

"Improved range resolution for FMCW HF surface wave radar"

A modified signal processing for FMCW waveform has been proposed that yields an improved range resolution without increasing the transmitted signal bandwidth. The chirp duration is reduced by an appropriate factor while the interval of the beat signal sequence considered for the range transform is kept constant. This modification implies a range transform over several chirp sweeps and an interleaving technique for the Doppler transform. Range resolution is improved without affecting the maximum unambiguous Doppler. This is achieved on the expense of a reduction of the maximum unambiguous range. Actually, this is not a restriction for HF SWR systems where the maximum range is limited by surface wave attenuation. However, a minimum practical range bin size is given either by the size of the targets considered or by the acceptable size of range side lobe level coming along with increasing range resolution. With this approach first and second order sea clutter is reduced which is of significant interest for ship detection. [C388]

"An improved CFAR detector for non-homogeneous clutter environment"

An improved CFAR detector for non-homogeneous clutter environment is proposed. At LFMCW radar receiver, after moving target detection (MTD) and linear-law envelop detector, CFAR detector is usually adopted to detect radar targets, the threshold of CFAR detector should be adaptive to the local background noise/clutter environment. Interfering targets often exist in the leading and lagging windows of the test cell which results in an increased detection threshold and a degraded probability of detection (PD). In the improved CFAR detector, an order statistic VI CFAR detector (OSVI-CFAR) is proposed to adaptively remove the interfering targets from the reference windows and increase the PD. Simulation and experiment results are given to prove the feasibility of the OSVI-CFAR detector. [C389]

"A miniaturized broadband four-port antenna based radar detection system"

A novel compact four-port antenna based receiving radar detection system is presented. Emphasis is placed on the antenna and pattern transform algorithms development. The antenna, with size of 113 Ч 113 Ч 33.7mm3,

operated within 1.0-1.8GHz (s11 <; -10dB) and 5.5dBi single port gain, is designed and integrated successfully in a specific cylindrical stepped conductor. Two different pattern transform algorithms corresponding to 3 excited modes for the four-port antenna are developed and firstly compared with indoor experimental results. It shows that a indoor target can be detected successfully by the radar system with spatial resolution of 3 degrees, which is agreement well with the numerical simulations. [C390]

"3D Electromagnetic imaging using compressive sensing"

We develop the application of compressive sensing (CS) for solving general inverse electromagnetic problems such as three-dimensional (3D) microwave imaging. The goal is to estimate locations of unknown, but sparse targets, hidden inside dielectric bodies. The potential of CS for localizing sparse targets in vacuum or buried in ground was shown in previous work. We extend the proposed schemes by considering arbitrary embedding medium and exploiting dual-polarized measurements. We compare the performance of CS and beamforming in the breast-cancer estimation problem. [C391]

"Polarimetric suppression of early-time scattering for late-time target identification"

One can suppress the strong signal amplitude of the early-time scattering, relative to the late-time signal containing the natural resonances (for target identification) using various techniques. This paper discusses the use of polarization for the early-time suppression. [C392]

"Detection and coordinate measurement of targets by ultra-wide band radar with antenna array"

Algorithms of digital signal processing are widely used in modern ultra-wide band (UWB) radars to solve problems of target detection and coordinate measurement. The paper deals with general algorithms of signal processing in ultra-wide band short-pulse radar with antenna array. The radar is developed for the monitoring of moving objects placed behind of radio-transparent barriers. The results of mathematical modeling are presented. [C393]

"The motion trajectory restoring for radar observation of living objects"

Some technologies of medical radars design are discussed in the report. Radars are intended to obtain the mechanical moving trajectory of living organism chest. Peculiarities of radar detection of targets performing seesaw motion are considered. Data obtaining and processing problems are investigated, methods of initial object motion trajectory restoring are examined by means of two quadratures use, constant component elimination and arctan-demodulation. Methods of received signal processing and computing are proposed. [C394]

"UWB noise acoustic atmospheric radar"

In this paper we discuss a new approach to create the acoustic atmospheric radar (sodar) which is based on noise sounding waveform. Such sounding waveform fits all formal requirements to UWB signals and has remarkable characteristics including extremely high range and speed resolution. It is important to remember that all these good properties exist only in the case when we have independent samples. The noise signal forms the independent samples because of its nature. The prototype of the radar is described and investigated theoretically, using computer simulation, and in natural conditions. Non-parametrical signal processing algorithm is developed based on statistical approach and digital signal processing. It has wonderful properties of invariance to the group of the noise and signal transforms and stable level of the false alarm probability can be applied for both acoustic and microwave UWB noise radars. The use of the FFT algorithm increases the speed of calculations and gives us the possibility of constructing digital random signal radars. The results of this project confirm that the random signal radar is one of the most interesting types of radar. It combines properties of UWB radar with some additional features, based on random nature of the sounding waveform. These new properties allow us to simplify signal detection algorithms and measure a distance, an azimuth and a target velocity simultaneously with high resolution and accuracy. [C395]

"The Study of Moving Target Detection Algorithm Based on Wind Field Detected by Lidar"

Aiming at the situation that normal detection means is hard to find the airborne moving target that has a small RCS and rapid moving speed characteristics, the algorithm of moving target detection is presented based on atmospheric wind field disturbing data detected by lidar. First, through receiving atmospheric wind field disturbance information that is produced by the airborne moving target moving on the air, and the excellent characteristics that lidar has in the detection atmosphere, atmospheric wind field disturbing retrieval model is established to acquire moving target space field distribution condition. Moving target space field change data is acquired based on filtering background air disturbance information, Moving target detection is carried out based

on moving target detection algorithm. The result shows there is consistent between moving target detected by the algorithm and experimental result. An effective approach of greatly improving moving target detection ability for the low_detectable target is supplied. [C396]

"A practical ground penetrating radar signal processing method based on wavelet transform"

Wavelet transform is a new applied signal processing technique in recent years, its time-frequency multi-resolution and signal processing performance are analyzed in the paper. A practical ground penetrating radar signal processing method based on wavelet transform is proposed; it contrast with continuous wavelet transform, the experiments indicate that it improves the processing performance of underground target detecting. [C397]

"Target recognition for marine search and rescue radar"

The key point of marine search and rescue is to find out and recognize the distress objects. At present, the visual search method is usually adopted to detect the ships in distress, and this method can only be used at good sea condition and visibility. In this paper, a new target detection and recognition system is proposed. The parameters of radar transmitter and echo graphics and the invariant moments of radar images are extracted as the system's recognition features, and the system's target classifier is based on BP neural networks. The developed recognition classifier has been tested using three kinds of target images, the target's features are used as the inputs of trained BP neural networks and the outputs of networks are target classification. Sea experimental results show that the proposed method is well-clustering and with high classified accuracy. [C398]

"An Adaptive Radar Detection for the Target in Clutter with Unknown Covariance Based on the PPPT"

In this paper we consider the problem of radar detect a fluctuating target in Gaussian clutter with unknown covariance. To this end we devise the detector based on the prior posterior ratio test (PPPT) criterion. The likelihood ratio is the prior-posterior PDF ratio of amplitude of the echo from the target. For the estimate of the unknown covariance of the clutter, We resort to the Maximum likelihood ration method, which means to minimize the posterior PDF of the amplitude of the echo. The simulation results show that the devised detector has a much better performance compared to the GLRT detector. [C399]

"Coherent MIMO radar"

Multiple-input multiple-output (MIMO) extensions to radar systems enable a number of advantages compared to traditional approaches. These advantages include improved angle estimation and target detection. In this tutorial, an overview of MIMO radar is provided, and the concept of coherent MIMO radar is defined. In addition, two topics are addressed more thoroughly: MIMO waveform/array geometry optimization for target tracking, and MIMO ground moving target indication (GMTI). [C400]

"Waveform diversity & knowledge based systems"

Summary form only given. Waveform diversity is an emerging technology that has dramatically altered the development of futuristic radar systems, as has knowledge based processing and control. With increasing numbers of radio frequency sensors and communications systems, battlefield scenarios have become more complex and continuously redefined. Our challenge will be to effectively use this technology to enhance overall performance of advanced radar systems operating within available spectrum in these battlefield environments. Technologies essential to this goal include cognition and knowledge based systems for waveform generation timing and control, and intelligent radar signal/data processing for detection, parameter estimation and track processing. Cognition is defined as the act or process of knowing, including both awareness and judgment. Awareness of the dynamically changing spectral environment and judgment for the selection of optimal waveform parameters and sensor placement will enable dramatically improved performance for target surveillance/reconnaissance in addition to enhanced interference mitigation. A confluence of factors and technologies now makes waveform diverse knowledge based systems a logical and affordable alternative to classically designed radars. [C401]

"Pulse Doppler radar waveforms"

Modern military airborne radars are highly sophisticated, multi-mode systems which are required to detect difficult targets in all aspects and over a large range/velocity detection space. There are particular difficulties associated with the airborne case such as the limited antenna aperture, high platform velocity and severe clutter levels which present difficult waveform design challenges. This tutorial will consider the design parameters of high pulse repetition frequency (PRF) and medium PRF waveforms commonly used in airborne pulse Doppler radar

modes. The majority of this tutorial will be devoted to the issues concerning the selection of the number of PRFs and of the PRF values used in the medium PRF mode. PRF optimisation methods using evolutionary algorithms used by the author and his colleagues in a number of recent studies will be described. Examples will be given of airborne fire control radars, airborne early warning systems and active radar seekers used in anti-aircraft missiles. [C402]

"Blind channel estimation for MRC systems with maneuvering transmit/receive terminals"

This paper presents a new blind channel estimation technique for maximum-ratio combining systems where the relative speed of the transmit/receive terminals may change. This changing speed is called maneuvering. The proposed blind system has a hard decision switching block which selects between different speed modes of a maneuvering terminal. The speed can be therefore tracked in a mobile data communication link. This is accomplished based on only the received data information signal, i.e., no other information (for example from a speed sensor or radar, etc.) is required. The performance of the proposed technique is evaluated by simulation and comparison is made with optimal coherent detection. The importance of introducing the switching block can be demonstrated by disabling it in the algorithm, and this results in a large degradation in performance. To assess the direct impact of the proposed blind channel estimation on the error performance, a fair comparison with a known, blind technique based on Kalman filtering is also made, with the assumption of non-maneuvering terminals. Here, improved performance is observed. [C403]

"A Viterbi data association algorithm based on adaptive clutter density model"

There are many false tracks which are produced by large of non-uniform and non-stationary distributed false clutters in the OTHR target tracking. To solve this problem, an adaptive clutter model is introduced into the Viterbi data association algorithm, and on this basis an adaptive clutter model Viterbi data association (ACM-VDA) algorithm is put forward. Simulation results show that the number of false of ACM-VDA algorithm will be much less than that of VDA algorithm and VDA-AI algorithm. [C404]

"Assessment of statistical models for clutter and target in SAR images"

Accurate knowledge of statistical properties of SAR data plays an essential role in SAR image processing and understanding. Several studies have been made for discovering the relationship between the physical features and statistical properties of SAR data, and some statistical models for modeling SAR data having been proposed and studied. In this paper, we focused on four often used statistical models: the Weibull, Log-normal, Gamma and K distributions. These models are used to fit target and clutter regions in SAR data provided by MSTAR, and through three different goodness-of-fit tests, we assess the performance of the four statistical models for modeling the clutter and target in the SAR images. The results show that K distribution performs best and Log-normal performs worst for modeling clutter region, on the other hand, Log-normal distribution performs best while K distribution performs worst for modeling target region. [C405]

"Performance analysis of sequential detection in early warning radar applications"

In early-warning radar surveillance environment, sequential procedures are preferred to detect the targets, for they promise a reduction in the time needed to take a decision. In this paper, a sequential detection algorithm is concerned and the interplay between the parameter dsnr and the system performance is mainly discussed. Numerical results have shown that sequential detector can lead a great reduction in the average-sample-number (ASN) especially in high SNR. In order to get a proper system performance, a trade off should be made between the ASN and detection performance when choosing the parameter dsnr. [C406]

"HRR detection theory in coherent Weibull clutter"

In this paper, we first introduce the definition of spherically invariant random vector (SIRV) and then give the representation of Weibull distribution by SIRV and two detection algorithms for Weibull clutter. In particular, the optimum detector is derived for the distributed target by the Neyman-Pearson (NP) criterion. Since the optimum NP detector is impossible to realize at the practical situations, we also introduce the GLRT-based adaptive detector. Finally, the numerical results show that the performance loss due to adaptively estimating the covariance matrix and texture component is negligible. [C407]

"An entropy-based HRR detection strategy in compound Gaussian clutter with partially correlated texture"

This paper addresses the detection strategy of a single pulse for range-distributed targets. The background is assumed to be compound Gaussian-distributed clutter with partially correlated clutter. Firstly, the definition of

information entropy is introduced. Then, a new nonparametric detection strategy based on Renyi's quadratic entropy is proposed. Moreover, we present numerical results for the performance analysis of the newly proposed detector, which suggest that the entropy detector is robust and outperforms the conventional integrated detector. [C408]

"An algorithm of resolving the range ambiguity using a single PRF"

A new algorithm of range ambiguity resolution is presented which is substantially different from previously proposed algorithms. The algorithm utilizes a constant pulse repetition frequency (PRF). Firstly, a merit function is designed according to the moving characteristics of the targets. Secondly, range ambiguity resolution is achieved by minimizing the merit function. Numerical simulation results indicate that the proposed algorithm can resolve the range ambiguity efficiently using a single constant PRF. [C409]

"Reduced rank detection algorithms for distributed array sensors"

Distributed sensing systems provide an inherent spatial diversity by viewing a potential target from different aspect angles. Even though the centralized fully adapted processing scheme provides optimum performance, it is impractical for reasons of computational complexity and the sample support required for weight training. This paper presents two decentralized reduced rank STAP algorithms to overcome the drawbacks of centralized fully adapted processing. [C410]

"Parallel Registration and Time Synchronization Algorithm for Radar System"

Novel parallel algorithm for detection biases and time offset for radar system is introduced. The target position error of different radars is expressed by time offset and radar detection biased. This kind of relation leads to the linear least square estimation algorithm. Although such algorithm is deduced from constant speed moving target, equations for accelerating target can also be expressed. Through simulation, the efficiency of such algorithm is validated. The estimated time offset is not only precise, but also not sensitive to radar random error and system bias. [C411]

"Cross Entropy Optimization of the Random Set Framework for Multiple Instance Learning"

Multiple instance learning (MIL) is a recently researched technique used for learning a target concept in the presence of noise. Previously, a random set framework for multiple instance learning (RSF-MIL) was proposed; however, the proposed optimization strategy did not permit the harmonious optimization of model parameters. A cross entropy, based optimization strategy is proposed. Experimental results on synthetic examples, benchmark and landmine data sets illustrate the benefits of the proposed optimization strategy. [C412]

"Adaptive Enhancement with Speckle Reduction for SAR Images Using Mirror-Extended Curvelet and PSO"

Speckle and low contrast can cause image degradation, which reduces the detectability of targets and impedes further investigation of synthetic aperture radar (SAR) images. This paper presents an adaptive enhancement method with speckle reduction for SAR images using mirror-extended curve let (ME-curve let) transform and particle swarm optimization (PSO). First, an improved enhancement function is proposed to nonlinearly shrink and stretch the curve let coefficients. Then, a novel objective evaluation criterion is introduced to adaptively obtain the optimal parameters in the enhancement function. Finally, a PSO algorithm with two improvements is used as a global search strategy for the best enhanced image. Experimental results indicate that the proposed method can reduce the speckle and enhance the edge features and the contrast of SAR images better with comparison to the wavelet-based and curve let-based non-adaptive enhancement methods. [C413]

"Study on the Applicability of PJ Model on Part Coastal Sea of China"

The theories of evaporation duct and Paulus-Jeske model were briefly described, at the same time the methods of measuring the evaporation duct on the sea were introduced. In order to study the applicability of Paulus-Jeske model in coastal sea, the distribution of duct height errors and duct strength errors calculated by Paulus-Jeske model on different distance sections off the shore was analyzed, using the refraction index profiles and offshore hydrometeorology data collected experimentally in sea areas near the shore in recent years. The results could be took as reference for the studies on the detection of targets over the horizon on the sea with radar on the shore. [C414]

"SAR image target recognition based on NMF feature extraction and Bayesian decision fusion"

In this paper, a new approach of synthetic aperture radar (SAR) image target recognition based on non-negative matrix factorization (NMF) feature extraction and Bayesian decision fusion is presented for recognizing ground vehicles in MSTAR database. First, feature vectors are extracted from image chips by NMF algorithm. Support vector machine (SVM) is used to classify the feature vectors. After multiple views of the same vehicle collected at different aspects are classified by SVM, the outputs are fused by Bayesian decision fusion algorithm and then the final classification decision is generated. We evaluate NMF algorithm and the Bayesian decision fusion approach. Experimental results indicate that there are significant target recognition performance benefits in the probability of correct classification when NMF algorithm is applied and three or more views are used for Bayesian decision fusion. [C415]

"Diagonal Loading for STAP and Its Performance Analysis"

For the moving target detection with space-time adaptive processing (STAP), the non- homogeneity will cause the covariance matrix estimation error, which substantially results in the STAP performance degradation. Diagonal loading has long been used as a means to improve the robustness of the spatial filter against mismatches in both the desired spatial signature and the spatial correlation matrix. In this paper, we consider the application of diagonal loading to improve the detection performance for STAP, especially for the covariance matrix mismatch (statistical mismatch) in STAP, namely, there is a mismatch between the actual covariance matrix of interest and the presumed one. For the diagonal loading, the key problem is the choice of the loading level, and the method for selecting the loading level is given, and the particular performance analysis indicates that the diagonal loading can improve the detection probability and the output signal-to-noise ratio. Numerical simulations attest the validity of the analysis. [C416]

"Speed Measurement and Error Simulation for Three Stations Linear Array with Very Short Baseline"

The method by single station speed measurement presented in reference is further expanded. This calculation method can directly survey the uniform flight speed of target, only based on the actual measured frequency, by three stations linear array with very short baseline. Firstly, making use of Doppler changing rate, we can obtain both the specific value of advance angle and the specific value of frequency difference between adjacent measuring stations. Then, by combining it with the specific value of Doppler shift between adjacent measuring stations, the initial solution of advance angle can be solved. In order to exactly solve the advance angle, the relationship between tangential velocity and Doppler shift is found by decomposing Doppler shift in each detection nodes which is used for iterative computation. And then, the tangential velocity of Doppler changing rate is replaced by the one obtained from Doppler shift and iterative computing equation is constructed. The elementary analog calculation shows that analog error is not inversely proportional to basal line length and the iterative program can still produce true result when the basal line length is by far less than a wavelength. [C417]

"Bat-inspired multi-harmonic waveforms"

Bats achieve remarkable target detection and selection performance in the most challenging environments. These activities are carried out mainly by echolocation, i.e. by transmitting pulses at ultrasound frequencies and processing the echoes from targets. Because they have relied on high level performance for survival, as a consequence of natural selection, it is believed that they have evolved in order to optimise these capabilities. Echolocation calls are very sophisticated, diverse, and commonly composed of a number of harmonic components. If evolution has resulted in multi-harmonic waveforms there might be advantages deriving by doing so. In this paper we simulate multi-harmonics waveforms and exploit advantages or disadvantages by a range analysis of their ambiguity functions. Results are discussed in relation to the radar and sonar case. [C418]

"Phase-modulated waveform design for the target detection in the presence of signal-dependent clutter"

The problem to be considered is a phase-modulated waveform design for detection of extended targets contaminated by signal-dependent clutter returns and additive channel noise in practical radar systems. We first introduce an optimal waveform design algorithm for extended target detection in a band-limited radar system by maximizing the signal-to-clutter-and-noise ratio (SCNR) at the output of the receiver, and give the analytical solution of the optimal signal energy spectral density (ESD). In order to make full use of the transmission power, a phase iterative algorithm to design the phase-modulated waveform with constant envelop is proposed, which is proven to be able to achieve a small SCNR loss by minimizing the mean-square spectral distance between the optimal waveform and the designed one. The results of extensive simulations illustrate that our approach provides less than 1 dB SCNR loss when the signal duration is greater than 1 μs. [C419]

"Compressive radar imaging using white stochastic waveforms"

In this paper, we apply the principles of compressive sampling to ultra-wideband (UWB) stochastic waveform radar. The theory of compressive sampling says that it is possible to recover a signal that is parsimonious when represented in a particular basis, by acquiring few projections on to an appropriate basis set. Drawing on literature in compressive sampling, we develop the theory behind stochastic waveform-based compressive imaging. We show that using stochastic waveforms for radar imaging, it is possible to estimate target parameters and detect targets by sampling at a rate that is considerably slower than the Nyquist rate and recovering using compressive sensing algorithms. Thus, it is theoretically possible to increase the bandwidth (and hence the spatial resolution) of an ultra-wideband radar system using stochastic waveforms, without significant additions to the data acquisition system. Further, there is virtually no degradation in the performance of a UWB stochastic waveform radar system that employs compressive sampling. We present numerical simulations to show that the performance guarantees provided by theoretical results are achieved in realistic scenarios. [C420]

"A multi-target detector using mutual information for noise radar systems in low SNR regimes"

Target detection is one of important roles of radar systems. In this paper, we present a detection method using total correlation based on information theory for noise radar systems which enables a system detects multiple targets at low signal to noise ratio regimes. The proposed method utilizes the largest eigenvalue of the sample covariance matrix to extract information from replica of the transmitted signal, and can perform better than the conventional total correlation detector when reflected signals have intermediate or low signal to noise ratio. In addition, in order to avoid ambiguous target detection, we find thresholds to guarantee the detection performance with the same receiving antenna elements for a given false alarm probability. The threshold is computed from the largest and smallest eigenvalue distributions based on random matrix theory. Simulations show the proposed detection method can be used for intermediate and low signal to noise ratio environments, and the thresholds provides exact target detection. [C421]

"Two-Step Moving Target Detection Algorithm for Automotive 77 GHz FMCW Radar"

Today, 77GHz FMCW (Frequency Modulation Continuous Wave) radar sensors are used for automotive applications. In typical automotive radar, the target of interest is a moving target. Thus, to improve the detection probability and reduce the false alarm rate, an MTD(Moving Target Detection) algorithm should be required. This paper describes the proposed two-step MTD algorithm. The 1st MTD processing consists of a clutter cancellation step and a noise cancellation step. The two steps can cancel almost all clutter including stationary targets. However, clutter still remains among the interest beat frequencies detected during the 1st MTD and CFAR (Constant False Alarm) processing. Thus, in the 2nd MTD step, we remove the rest of the clutter with zero phase variation. [C422]

"A Novel Range Detection Method for 60GHz LFMCW Radar"

The linear frequency-modulated continuous-wave (LFMCW) millimeter-wave radar has been widely used in automotive industry applications. The motivation of this paper is to propose a segmented range detection (SRD) method on the foundation of plentiful mature research on the target detection of LFMCW radar. According to the SRD method, the detection range (about 150m in the scene of vehicular collision warning) is divided into several segments and triangular modulation waveform which consists of several different frequencies is designed. Compared with typical digital signal processing method, the SRD method can availably decrease the bandwidth of the IF signal, therefore the in-band noise will be significantly reduced and the signal to noise ratio (SNR) improved. Additionally, different range resolutions can be achieved and average range resolution improved. The SRD method is also validated through multiple outdoor experiments with the use of 60 GHz LFMCW millimeter-wave radar system designed by our research group. The efficiency of the SRD method is demonstrated in terms of ranging accuracy and range resolution after the analysis of experiment results. [C423]

"The impact of internal clutter motion on a sample matrix inversion space-time adaptive processing algorithm and the GMTI minimum detectable velocity"

A MATLAB simulation was constructed to better study the effects of internal clutter motion on a notional X band monostatic airborne radar employing a ground moving target indicator (GMTI) algorithm to detect slow velocity targets of low radar cross section. A sample matrix inversion (SMI) fully adapted post-Doppler space-time processor (tapered and untapered) was utilized and the internal clutter motion model of Ward [1] was applied to the overall simulation. As one would expect, the untapered version yielded slightly better results but in all cases final minimum detectable velocities of about 1.0 meter/second were obtained. By judicious choice and implementation of a reduced rank/dimension algorithm, it should be possible to obtain similar MDV results.

[C424]

"Parameter estimation of moving target based on linearly constrained space-time adaptive monopulse technique"

Technique of space-time adaptive processing (STAP), which is usually employed by airborne radar to reject the ground clutter and jamming and at the same time, detect the ground moving targets, can not estimate the spatial-temporal parameters of the corresponding targets. Monopulse technique, as a mature method for parameter estimation can be used on airborne radar, however, the estimation performance of this method is dramatically effected by the ground clutter and jamming components present, even when these components falls into the mainbeam interval. By combining the STAP technique with the monopulse technique, a new method for estimating the spatial-temporal parameters of moving targets is proposed and referred as to LC-STAM in this paper. Additionally, the proposed method utilizes the beam null, monopulse slope, and decoupling constraints to remove the worse influence on the beam shape from the mainbeam clutter, maintain the characteristic of the monopulse ratio, and increase the veracity of parameter estimation. Simulation results illustrated that the LC-STAM method possesses the excellent estimation performance of the spatail-temporal parameters by comparing with the other similar methods. [C425]

"Polarimetric Characteristics Analysis of Ship Target and Its Azimuth Ambiguities Based on PolSAR Images"

Azimuth ambiguities in SAR image are very common phenomena. The ambiguities are visually identifiable due to their high intensities in low radar backscatter background of sea environment. The ambiguities can be mistaken as ships and cause false alarms in ship detection. Therefore, for maritime applications (i.e. ship target detection), it is important to analyze the characteristic of azimuth ambiguities of targets. By using Eigenvalue-Eigenvector decomposition method, we analyze the polarimetric characteristics of ships and ambiguities. We conclude that the eigenvalues can be used to differentiate ship target and its azimuth ambiguities. One C-band JPL AIRSAR polarimetric data has been chosen to validate the conclusions. [C426]

"Identify Islands by Complex SAR Image"

The performance of interferometric synthetic aperture radar (INSAR)-based objects identifying in sea environment with clutter background is researched by many literatures, but most of them are mainly about detecting dynamic objects, such as ship targets. A new method is presented in this paper, which utilizes SAR image and point target analysis method to identify islands on sea surface in near and far range from mainland, especially for islets which can be confused with big ship or other objects such as floating, oil platform and so on. In the sea, either islands or islets is static objects, and other thing is dynamic characteristics, according to this characteristics, islands can be distinguished by spaceborne synthetic aperture radar (SAR) images joint point target analysis (PTA) method. The processing procedure includes three main phases: interferometric phase fringe, coherence evaluation, and sublook analysis. This method is applied with TerraSAR-X SSC image in HONHKONG area. [C427]

"Target Recognition Based on the Self-Correlation Function of HRRP"

The theoretical result shows that the self-correlation function not only has the time-shift invariant feature, but also largely reduces the computational work. To overcome the sensitivity of High-Resolution Range Profile(HRRP), this paper has extracted the self-correlation function of HRRP as a feature for target recognition. Templates and test data are created by using the measured data of sea targets. The results of comparison among the self-correlation function feature, the original range profiles and the amplitude spectrum feature show that the self-correlation function feature has higher recognition efficiency and better anti-noise performance. [C428]

"The Sky-Scanner System for Air Traffic Management: Test Sessions and Statistical Analysis"

Air Traffic Management (ATM) is traditionally performed by means of radar systems, but new detection and ranging systems based on LIDAR (LIgth Detection And Ranging systems) are emerging as a critical design trend and yielding to new generation ATM paradigms. The main goal of the designers of the system under discussion was to develop a novel laser tracking technology (SKY-Scanner System) that could allow the detection and tracking of aircrafts up to at least 6 nautical miles. Moreover, the purpose was also the definition of techniques, protocols, numerical prediction tools and devices specifically designed for the analysis of the laser system performances in Air Traffic Control applications. The ultimate purpose was to define a new generation ATM paradigm that is based on radar and laser tracking data fusion, as well as on ground to air laser

communications. This paper reports the test session that has been run on a prototype of the laser range finder, in order to find accuracy and possible dependence of measurement errors on temperature, humidity, distance and position of the target. The results show that high humidity and temperature can affect the accuracy of the measurements. [C429]

"A Detector of DTTB Based Passive Radar Using FRFT and Hough Transform"

Detecting weak moving targets is an important task for digital television terrestrial broadcasting (DTTB) based passive radar. The cross ambiguity function (CAF) suffers from the range and Doppler frequency migrations caused by the velocity and acceleration of the targets. The integration gain can't increase anymore. A new detector is proposed for this problem. In this detector, the fractional Fourier transform (FRFT) is used to compensate the Doppler frequency migration, and the Hough transform is utilized to accumulate the echo of the moving targets during the long integration time. The block diagram and the procedure of this detector are given. Simulation results show that the proposed method can detect weak moving targets effectively. [C430]

"Detecting and Identifying Two Stationary-Human-Targets: A Technique Based on Bioradar"

Bioradar is a novel kind of radar combining the technology of radar and biomedical engineering. It can detect vital signals (such as breath, heartbeat, movement, etc.) in a certain distance through the nonmetal substances (such as brick walls, rubble, etc.) without using electrodes or sensors. However, multi-stationary-human-target identifying and locating has not been resolved yet. Based on the Ultra Wide-band (UWB) bioradar, we developed a method combining biomedical signal processing and space-frequency analysis to distinguish two stationary human subjects in different distances and to identify the location of each human subject. Experiments were done to evaluate the effectiveness of the proposed method. In 86 data sets the accuracy of distinguishing two stationary subjects reached 73%. This method may serve as a basis for further studies in developing appropriate 2-Dimension locating image reconstruction models via multi-antenna (static) UWB radar. [C431]

"Navigation Satellite Passive Radar Moving Target Detection and SAR Imaging Based on FRFT"

Conventional radars have less invisibility, but the passive radars based on TV, FM signals also have some restrictions in SAR imaging by a range of issues such as ground electromagnetic environment and signal silence. This paper presents a new method of passive SAR imaging based on navigation satellite signal with single/multiple receive-only mode in FRFT domain. The received reflection of single multiple GPS signals from target is approximately linear FM signals which can be transformed by FRFT for signal frequency and Doppler frequency detection and estimation, especially for the target SAR imaging. Simulation results shown the effectiveness of the algorithm, and help to avoid the multi-target SAR imaging interference. [C432]

"Study on Defocus compensation using variable pulse repetition time stepped-frequency waveform"

In this paper, a new technology for compensating the defocus due to the velocities of multiple moving targets is presented. By using this technology, the blur produced by defocus can be compensated when the velocities are unknown. And a method is proposed to solve the range-Doppler coupling caused by the multiple targets. The effectiveness of the algorithm is illustrated with simulation results. [C433]

"Simulation of radar electronic warfare range of visualization applications"

At present, applications of visualization technology are expanding, and are playing an increasingly important role in various fields. In this paper, radar visual range of electronic warfare simulation has been studied based on transcendental equation method and graphic space intersection method. This paper gives the maximum radar detection range and the detection range of two-dimensional visualization in electronic warfare simulation. In the actual simulation application, a preliminary design achieves the expected target. [C434]

"A survey on feature extraction of SAR Images"

The feature extraction is one of the key steps for SAR ATR. It can greatly reduce the amount of information processing by SAR ATR, improve the identification efficiency, reduce the time of recognition and lower resources utilization by means of the feature extraction. In the beginning, the feature extraction methods are classified by target type and then various categories methods are summarized. Finally, some unsolved problems of feature extraction are probed. [C435]

"Fast Target Detection for SAR Images Based on Weighted Parzen-Window Clustering Algorithm"

To solve the inefficiencies and high false alarm probability problem of the target detection in synthetic aperture

radar (SAR) images and to improve the weakness of the two-parameter CFAR detector, a fast constant false alarm rate(CFAR) algorithm based on Weighted Parzen-window clustering (WPWC) is proposed. The principles and flow of the WPWC algorithm is introduced and a fast two parameter CFAR detector taking WPWC as a preprocessing, which reduced the effect of clutter and eliminated many false target detections from background. According to the theoretical performance analysis and the experiment results of some typical SAR images, the proposed algorithm is shown to be of good performance and strong practicability. Meanwhile, the corresponding fast algorithm greatly reduces the computational load. [C436]

"The Detection of Range Extended Target Based on Adaptive Searching and Twofold Sliding Windows"

The detection of range extended target in UWB radar has been the research focus in the field of signal detection. The paper gives a detection method based on twofold sliding windows, and the theoretical value of the detection threshold using adaptive searching algorithm is derived. The simulation confirms that the detection of range extended target based on adaptive searching and twofold sliding windows shows good performance. [C437]

"Multitarget Tracking Before Detection via Probability Hypothesis Density Filter"

Tracking-before-detection (TBD) is well suitable for radar detection and target tracking of low-observable objects because it makes full use of the raw sensor data without using the threshold and takes advantage of the gains of time integration. The main difficulty in the TBD is that the measurement is a highly nonlinear function of the target state and the associations of measurements are hard to be built when multiple targets are presented. Probability hypothesis density (PHD) filter is regarded as an efficient solution to multitarget tracking problems. To deal with multitarget TBD problem, a classical PHD filter, with "standard" multitarget measurement model, is proposed in this paper. The advantage of proposed filter is analyzed compared with traditional multitarget particle filter. Numerical simulations show our approach has better performance in estimated accuracy and precision of position, velocity and number of targets than multitarget particle filter. [C438]

"A New Method for Target Aspect Estimation in SAR Images"

The target aspect estimation is important to Synthetic Aperture Radar Automatic Target Recognition (SAR ATR). Due to the nature of SAR imaging, the front edges are comparatively distinct and stable features in target images, and are suitable for target aspect estimation. In this paper, a new method is proposed for target aspect estimation. A simple adaptive threshold processing is used to extract the strong scatters in target area. By analysis on the projection distribution in different directions of the strong scatters, the normal front edge response is defined and is used as basis of the aspect estimation. The 90-degree correction is carried out on several unreliable results in the last step. According to the results of experiments on the MSTAR public database, the proposed method can achieve the optimal performance compared with the major edge fitting method, while has simpler processing flow and higher computing efficiency. [C439]

"Study on the Time-Frequency Two Dimensional CFAR Algorithm for Moving Targets on Ground in PRC-CW Radar"

PRC-CW radar is mainly used to detect moving targets on ground. Ground clutter heaves fiercely, and its distribution is complex, which makes it difficult to detect targets correctly from time domain. The characteristics of moving targets and ground clutter differ in frequency domain. And the spectrum of targets may change with time, so, this paper designs the time-frequency two dimensional constant false alarm rate(CFAR) algorithm. Based on the analyze of pulse compression and moving targets detection(MTD) of this type radar, the two-dimensional CFAR algorithm is proved to be feasible via simulation. The results of simulation show that, the algorithm can measure the velocity and range of targets correctly. The clutter and noise are also restrained effectively. [C440]

"CCD camera and IGPS tracking of geophysical sensors for visualization of buried explosive devices"

High-resolution Ground Penetrating Radar (GPR) images of the ground surface and shallow subsurface are needed in order to detect and identify small buried explosive materials such as Anti-Personnel (AP) landmines. A key requirement to produce sharp visualizations is centimetre-precise sensor positioning with real-time imaging results. We are pursuing two complementary approaches to accomplish this task: 1) Sensor tracking with a CCD camera, 2) and large work volume Indoor GPS. In outdoor field tests both methods have successfully imaged small landmine targets, which has a plastic body of less than 10cm diameter. [C441]

"Infrared object tracking based on particle filter"

A novel infrared moving object tracking method based on particle filter and mean shift algorithm is presented in this paper. Based on the framework of particle filter, the mean shift algorithm is introduced as better proposal distribution to improve the sampling efficiency. Compared to conventional particle filter, the proposed method uses much fewer particles to maintain the multi-mode distribution, and overcomes the degeneration problem effectively. Experimental results on sequential images show that our method can track steadily when the object move fast or be occluded, the overall performance of the proposed method is better than traditional particle filter algorithm. [C442]

"The target detection for GPR images based on curve fitting"

Due to the complexity of the medium composition, physical characteristics and the spreading of electromagnetic waves, the extraction and automatic target detection of the Ground-penetrating Radar (GPR) is extremely complicated and has become an important issue in the practical application of GPR. In this paper, a method based on curve fitting is proposed by using the hyperbolic echo characteristics. The edge lines of GPR images firstly obtained by using image preprocessing methods and hyperbolas are fitted to approximate the edges. Finally, hyperbolic echo apex positions in the GPR images are extracted and marked on their apexes. The experimental results show that all targets are detected correctly. [C443]

"An improved fast Viterbi algorithm for track-before-detect"

This paper addresses the problem of moving dim target detection in radar systems using track-before-detect approaches (TBD), which are implemented by a fast Viterbi algorithm (FVA). Traditional Viterbi algorithms (VA) traverse all the resolution cells including many noise cells in every frame, whereas FVA improves the searching method by combining with a Constant False Alarm Rate (CFAR) approach to expel many noise cells, and provides the same performance with much less computational cost. What's more, it avoids target extend with no post-processing due to a novel maximization operation, and consequently reduces the complexity of the proposed algorithm. Simulation results prove the performance of the new algorithm. [C444]

"A comparison of two CA-CFAR loss calculation methods in spatially correlated K-Distributed sea clutter"

Radar target detection of targets in sea clutter modelled by compound K-distribution is examined from a statistical viewpoint by Monte Carlo simulations. The target detection is processed by Cell Averaging Constant False Alarm Rate (CA-CFAR) processor and the performance evaluations are quantified by CFAR loss. Curves for CFAR loss versus the spatial correlation and spikiness of sea clutter, number of cells of CA-CFAR processor and the number of non-coherently integrated pulses are presented. [C445]

"Metallic objects and oil spill detection with multi-polarization SAR"

In this study, two innovative physically-based approaches have been developed to detect man-made metallic objects and oil slicks in polarimetric SAR data. They are based on the different sea surface scattering mechanisms expected with and without oil slicks and metallic objects. Experiments, accomplished over Single Look Complex (SLC) Level 1.1 quad-pol L-band ALOS PALSAR SAR data, demonstrate the effectiveness of the two approaches for oil slick and metallic target detection purposes and witness the capability of ALOS PALSAR data for such applications. [C446]

"A novel method of SAR terrain target scattering signal simulation"

Synthetic Aperture Radar (SAR) raw signal simulation is crucial for SAR system design and processing algorithms. This paper proposes the simulation method of SAR scattering signal of big area terrain target. At first, the SAR imaging principle is analyzed. Then, the space-borne SAR scenario model is constructed. The echoes of point target are calculated, which is impulse response of the SAR signal acquisition system. In tradition, the Radar Cross Section (RCS) simulation parameters of terrain target calculation is based on the scattering model expressions of a random roughness surface and the electromagnetic wave shadow theory. The approach of this communication utilizes the practical SAR SLC (Single Look Complex) or MGD (Multi-Look Ground-range Detected) image as terrain target backscattering coefficient, instead of the traditional method aforementioned. Then, 2D-FFT method is utilized to improve simulation efficiency significantly. The results of simulation prove the validity of the approach. [C447]

"A random finite set based detection and tracking using 3D LIDAR in dynamic environments"

In this paper we describe a fully integrated system for detecting and tracking pedestrians in a dynamic urban environment. The system can reliably detect and track pedestrians to a range of 100 m in highly cluttered environments. The system uses a highly accurate 3D LIDAR from Velodyne to segment the scene into regions of interest or blobs, from which the pedestrians are determined. The pedestrians are then tracked using probability hypothesis density (PHD) filter which is based on random finite set theoretic framework. In contrast to classical approaches, this random finite set framework does not require any explicit data associations. The PHD filter is implemented using a Gaussian Mixture technique. Experimental results obtained in dynamic urban settings demonstrate the efficacy and tracking performance of the proposed approach. [C448]

"GPR modeling for landmine detection"

Ground penetrating radar (GPR), which can detect shallow buried low dielectric contrast objects in a variety of soils by non-invasive subsurface sensing, is a promising technology for imaging low-metal or non-metallic landmines. In this paper we present a complete model of a complex GPR scenario which is solved via finite element method, and includes the actual impulse GPR system, interface, soil and targets. We obtain time domain signatures for different testmines and small objects under different soil conditions which are satisfactorily correlated with measurements. The simulated responses give us a broad understanding about the factors which control the electromagnetic scattering by small objects and are used to interpret the characteristics of the signatures according to the target and background parameters. These obtained waveforms may be applied to reduce the false alarm. [C449]

"On the imaging applications of ground penetrating radar"

This paper presents a brief overview on the imaging aspects of ground penetrating radar (GPR). Different experiments in three fields of investigation are conducted to demonstrate the feasibility of GPR for the imaging of subsurface materials. First, the GPR signatures of electrically and dimensionally different objects located inside the sand pool are obtained and processed into a focused image. The resulted image reveals that even the targets which have inherently low-level returns can be located by GPR. The second experiment is aimed to detect the water leaks from the plastic pipes via GPR technique. It is shown that additional water around the leak manifest itself as reflecting regions in the image, thereby giving information about the leak location. Furthermore, the GPR measurement of concrete column is performed to locate and image the stirrups within the columns. The results dictate the usability of GPR for concrete column analysis in measuring the position and size of stirrups. [C450]

"The detection of long chirp signal with small frequency rate in low SNR"

The detection of a long linear frequency-modulated signal (LFM) with small frequency rate is studied in very low signal-noise ratio (SNR). By wigner-hough transform for each subsection of the signal, the LFM signal can collect a peak in each WHT plane. Making use of the character that and the peak moves continuously in multi-frame WHT plane is same as the moving target of a image sequence, a new detection technique combined WHT with image Processing is proposed. The technique is proved out by computer simulation of keeping good performance for this signal. [C451]

"CFAR and KPCA for SAR image target detection"

A SAR target detection model based on CFAR and KPCA is presented in this paper. This Detection is divided into a pre-screening and discrimination process. Within the large-scale and low-resolution SAR imagery, pre-screening adopts classic CFAR techniques, while the discrimination process adopts kernel principal component analysis to separate the target from clutter. Experimental results show that the detection performance of our algorithm appears to be superior to the classic CFAR methodology. The combination of both pre-screening and prior knowledge of targets can effectively enhance detection rate and inhibit false alarm at the same time. [C452]

"Target deteciton algorithm for spatial diversity MIMO radar with space partition"

For spatial diversity multiple input multiple output (MIMO) radar, target echo signals received by its widely separated antennas may be semi-correlated and different in SNR. According to the correlation and SNRs of received target echo signals, a space partition based target detection method is proposed, which partition the surveillance volume into two sections, one using the coherent accumulating detector and the other using the incoherent accumulating detector. The partition method is shown to achieve an improved detection performance at a low computation cost. [C453]

"A novel multi-channel SAR-GMTI algorithm based on raw data"

This paper presents a novel SAR-GMTI algorithm based on the range-compressed raw data. FrFT is introduced to the classical three-channel DPCA system to realize the moving target detection, parameter estimation and SAR imaging, acquiring an exact GMTI image of accelerative moving targets. As a pretreatment, Keystone transform is firstly applied to process the echoes receiving from each sub-aperture respectively in order to remove the range migration. Our scheme is available even under a clutter-rich and low SNR environment. The simulation results indicate the efficiency of the method. [C454]

"Fractal based detection using blind box-counting method in high resolution radars"

Sea clutter refers to the radar returns from the sea surface. Accurate modelling of sea clutter and detection of low observable targets within sea clutter are major problems in remote sensing and radar signal processing applications. Recently fractal geometry is applied to the analysis of high range resolution radar sea clutters. The box-counting method is widely used to estimate fractal dimension but it has some drawbacks rarely considered in literature. We explain the problem of box size range and present a novel method to select an appropriate range. [C455]

"Riemannian median, geometry of covariance matrices and radar target detection"

We develop a new geometric approach for radar target detection which is based on the notion of Riemannian median and the information geometry of covariance matrices. First of all, we give the definition of Riemannian median and a simple algorithm to compute it. After that, the explicit expressions of reflection coefficients parametrization of covariance matrices are obtained, with which the Riemannian metric on the manifold of covariance matrices has a very simple form. The explicit expressions of geodesics in the manifold are also obtained in order to facilitate the computation of the Riemannian median of covariance matrices. Finally, we give some simulation examples to illustrate the performance of this new method. [C456]

"Foreign object debris detection using a 78 GHz sensor with cosec antenna"

This paper presents the results of FOD measurements conducted using a broadband 78 GHz radar sensor. Previous studies with a short-range setup up to 30 m showed promising results. However, to meet the requirements of the intended application, the range has to be increased significantly. As for all radar systems, the range can be extended by increasing the transmitted power and/or the antenna gain. In this work two different folded reflectarray antennas with a cosec-shaped pattern have been used to improve the system performance and range. Together with a CFAR (constant false alarm rate) algorithm and a moving target indication advances could be achieved compared to the previous setup. [C457]

"Angle of arrival detection using Retrodirective RADAR"

In this paper, experimental results are shown for angle of arrival extraction using an analogue Retrodirective RADAR using PLL to an accuracy of 2.5°. Angle of arrival results from the Retrodirective RADAR were extracted from the low frequency IF phase of the PLL based phase conjugator. The target position can then be determined virtually instantaneously. Therefore the system does not require any complicated DSP post processing, so is able to operate with low power and relatively simple circuitry. This system is ideally suited to real time acquisition of fast moving projectiles. [C458]

"S band radar target detection in an extreme advection duct event"

Mesoscale numerical weather prediction models coupled with modern parabolic equation radar performance models have allowed the resolution of four dimensional radar performance in challenging non homogeneous near surface refractivity fields at the time and location of the modeller's choice. Large scale offshore flow of warm and dry air over colder seas produces strong surface ducting. Large land-sea temperature differences can produce near shore sea breezes and surface based ducts. This paper describes modelled radar performance in such a complex ducting structure over the Persian Gulf during large scale northwest flow. The refractivity field was resolved by the Coupled Ocean Atmosphere Mesoscale Prediction System and the notional radar performance was modelled by the Advanced Refractivity Effects Prediction System. The results indicate strong spatially dependent enhancements and degradations in radar performance relative to a standard atmosphere. [C459]

"Optimization of multistatic passive radar geometry based on CRLB with uncertain observations"

In the present paper, we derive the Cramer-Rao Lower Bound (CRLB) with uncertain observations, namely for Pd<;1, for the 2D position measurements of a multistatic passive radar, to optimize the geometry of the system. This is an extension of the enumeration method CRLB to the multisensor case, where it is considered that the

multiple receivers could detect or miss the target independently of one another. This version of the CRLB with uncertain observations is the correct measure for the realistic performance assessment of a passive radar, since typically passive radars show low values of Pdand neglecting the target miss probability, in the standard evaluation of the CRLB, provides unreliable performance assessments. The obtained CRLB is then used inside the multistatic passive radar optimization scheme derived by the authors in, to select the broadcast transmitters and the receiver locations providing the highest accuracy. The proposed approach is illustrated by means of a case study: a multistatic passive radar based on two transmitters of opportunity and a single receiver. For this case, we analyse how the Signal to Noise Ratio and the detection probability affect the measurement accuracy and the estimation accuracy and, finally, we use the theoretical CRLB to select the two transmitters among the available ones and choose the receiver location, for a target flying a specific trajectory. [C460]

"Through the wall MIMO radar detection with stepped frequency waveforms"

In this paper, we present through the wall (TTW) radar detection simulations with an emerging radar architecture which is the multiple-input multiple-output (MIMO) radar. The urban environment, especially in TTW detection, is very tough for radar detection. With the aim of improving the detection performances, we use several spaced antennas in transmission which gives a spatial diversity leading to different points of view of the scene. So as to keep diversity we choose linearly independant waveforms and more particularly we utilize the hyperbolic frequency hop codes. We first begin by introduce the problems and applications of TTW detection. Then we will present the geometric configuration of the scene and the wall attenuation and target modeling. After what, we will expose the waveforms used in transmission and the processing to perform detection. We finish with some preliminary results and conclude about this work. [C461]

"Target detection and positioning in correlated scattering using widely distributed MIMO radar"

Multiple-input multiple-output (MIMO) radars use different sources of diversity to improve the performance of the radar. A MIMO radar in which angular diversity is achieved by using widely distributed antennas has been proposed to reduce the impact of the fluctuations of the target radar cross-section. This type of system is also known as the statistical MIMO radar. Typically, it has been assumed that the scattering amplitudes of the signals received by different antennas are either fully correlated or independent depending on the configuration. However, the antennas may see similar aspects of the target in some situations leading to correlation in the scattering. In this paper, we show how the correlation of the scattering can be exploited to improve the probability of detection and positioning. This is achieved by using a parametric model for the correlation of the scattering. We also investigate how the correlation can be used for estimating the direction of arrival with an uncalibrated MIMO radar system. [C462]

"Evaluation of a high accuracy range detection algorithm for FMCW/phase radar systems"

The FMCW radar is the most versatile radar principle used today. Depending on the system configuration, it is possible to use an FMCW radar to detect targets in the range from hundreds of kilometers down to a few centimeters. This paper describes an algorithm, which can be applied to improve the FMCW range accuracy down to a few mm. Numerical system simulations are used to evaluate the possibility of using a combination between an FMCW and a phase radar for a line based range detection at 24 GHz. [C463]

"Medium-PRF detection by non-coherent integration"

The document describes a detection and inherent ambiguity resolution scheme for Medium-PRF waveforms. Medium-PRF waveforms are characterized by ambiguous measurements of both range and doppler. Ambiguities are resolved by changing the pulse repetition frequency (PRF) from burst to burst and by combining the ambiguous results of adjacent bursts. The classical binary integration procedure applies a detection threshold on burst level and combines detections from burst to burst including unfolding of the ambiguities. In this paper the more optimum method of non-coherent integration from burst to burst with inherent ambiguity resolution is discussed. The method provides a significantly improved detection performance. Of particular interest for non-coherent integration is the appearance of ghost targets. The paper proposes a method for deghosting. [C464]

"Microwave gauging with improved angular resolution"

Angular resolution of a microwave level gauge may have positive impact on the robustness of the target detection. Therefore, an azimuthal scan can be performed with the aid of electronical or mechanical beam-steering methods. The present paper provides an overview and a comparison of signal-processing methods which improve the angular resolution of such measurements. For a given antenna, improvements can be achieved well beyond the limit of the half-power beam-width (HPBW) of that sensor. Among others, the performance of the Wiener filter and the Kalman filter for a motion-free channel is examined in greater detail

since their application exhibits promising improvements on the angular resolution in both, simulations and measurements. In addition, the advantage of using a Kalman filter for a channel with statistical fluctuations is shown in simulations. [C465]

"Comparative analysis of two techniques for moving target velocity estimation"

In this paper two different algorithms for target velocity estimation are considered and compared. Traditional approaches for detecting and tracking moving targets typically rely on a multiphase strategy in which target detections are feed to a Kalman-filter-based tracker. In the present paper, two techniques for target velocity estimation in the framework of Hough Transform (HT) detection scheme are considered. The experimental results are obtained by means of numerical analysis. The quality parameter is estimated using the Monte Carlo simulation approach. A comparative analysis of the two velocity estimation techniques is done based on same parameters of the surveillance radar. The research work is performed in MATLAB computational environment. The obtained analytical results can be used in both, radar and communication receiver networks. [C466]

"Antenna size versus sea clutter rejection: A new analysis of coastal radar performances and optimization"

In the field of coastal surveillance radar, and more generally in maritime environment, the overall radar performance for the detection and tracking of small target is primarily linked to the capability of the radar to reject the sea clutter. Sea clutter is the radar signal return of the sea surface illuminated by RF waves and can often be a strong as the target radar return. A conventional method to counter sea clutter is to use very large antennas providing high angular resolution trying to optimize the signal to clutter ratio in the radar processing by defining the smallest possible illuminated cell of sea surface. This paper provides an in depth analysis of the pro and cons of large slotted waveguides antennas and shows that bigger is not better: Parasitic effects, correlated to antenna dimensions, in the beam forming process of big antennas tends to degrade the antenna performance and leads to the conclusion that the optimal antenna size is often smaller than the one currently used on existing coastal surveillance radars. [C467]

"Through the wall detection and localization of a moving target with a bistatic UWB radar system"

This paper presents a method for detecting and locating a moving target behind a wall with a bistatic UWB radar system. This method not only can locate a moving target, but can also be used to estimate certain parameters of a wall (dielectric constant and thickness). [C468]

"Solid state pulse Doppler radars for maritime traffic surveillance-Review of architecture and trade-off analysis"

Maritime traffic surveillance radars are in use for several decades, they are mostly based upon magnetron pulse emitters and simple non coherent signal processing. While the lack of coherent signal processing capabilities is compensated by strong pulse power, there is still a demand for improving detection and tracking performances especially in front of heavy sea clutter for detecting small and evasive targets. The solutions that address such demands are based upon the use of solid state transceivers which allow to generate and to process specifically designed waveforms incorporating for example frequency or phase codes. [C469]

"Passive detection and tracking of maneuvering targets with particle filter techniques using DVBT broadcasting"

We present a complete and practical particle filter-based scheme to detect, classify and track multiple maneuvering targets using DVBT-based passive radar. As in the conventional radar signal processing, the proposed technique first detects the target Doppler and bi-static range considering the outputs of long-term correlation matched filters whose level exceeds an adaptive threshold. The detections are then followed by a bank of particle based-filters. Each filter tracks a detected target and estimates its position and velocity from the analysis of short-term correlations. [C470]

"Co-array weighting in minimum-redundancy arrays for radar image enhancement"

The pronounced lobing of minimum-redundancy arrays-a class of thinned arrays-leads to image degradation in radar applications. Co-array weighting is investigated as a possible cure. Different distributions are considered. A comparative study of pattern degradation caused by random phase errors of the individual array elements is conducted. Multiple target detection-a critical aspect of nonlinear array processing-is addressed as well in this context. The potential of the proposed approach is critically assessed by simulation. The findings are confirmed by Ka-band radar experiments performed with a synthetic array. [C471]

"Detection against the background of non-Gaussian clutter from underlying surface"

The method for the operating characteristics of the radio systems estimation based on using of model of non Gaussian clutter from underlying surface (sea, land plots) is proposed. This method was done by nested semi-Markov based processes. The characteristics of parametric (Neumann-Pearson, adaptive control of threshold and filter band of moving-target indication) and non-parametric (sign and linear rank) detectors are analyzed theoretically and are compared to results of the experimental investigations. [C472]

"A multi-model track-before-detect algorithm for manoeuvring target detection for Over-the-Horizon Radar"

In this paper a multi-model track-before-detect (MM-TBD) is proposed for the HF Over-The-Horizon-Radar (OTHR) manoeuvring target detection. Multiple hypotheses about target manoeuvres and echo sources are represented in the multi-model-estimation framework with each sub-filter corresponding to one hypothesis. The track output of each sub-filter is obtained based on the maximum likelihood criterion and then a generalized likelihood ratio for hypothesis test is presented to target detection. A numerical simulation is presented to show the effectiveness of the proposed algorithm. [C473]

"Polarization diversity in Ultra-Wideband imaging systems"

This paper presents an Ultra-Wideband (UWB) indoor imaging system with dual-orthogonal polarized antennas. Both the measurement setup and the algorithm implemented for data processing are introduced. In the presented approach, a 4Ч1 vertically oriented antenna array is used in order to perform 2D scan. For 3D imaging, single antennas are applied. Emphasis is given to the polarization diversity, through which additional properties of objects such as form, surface structure and orientation are investigated. In this way, some objects are detected, which may remain invisible for single-polarized systems. In addition, the presented approach extends UWB-Radar/Imaging with very high resolution to a high-end system with robust target detection, while providing extensive information about the environment. Such a system can be of great interest in applications such as indoor search-and-rescue operations, motion tracking and indoor navigation. [C474]

"Target maneuver detection using high resolution Doppler profile"

A novel maneuver detector for radar targets is described. The high resolution Doppler profile is used to detect abrupt variation in attitude as the target maneuvers, which can be extracted within the coherent processing interval. A brief introduction of the detection principle is presented, along with feasibility study results from a back propagation neural network implementation. [C475]

"Information-theoretic algorithm for waveform optimization within ultra wideband cognitive radar network"

A novel information-theoretic approach for designing the excitation ultra wideband (UWB) waveforms within a cognitive radar network is developed. This method utilizes the mutual information (MI) between subsequent radar returns to extract desired information from the radar scene. With this approach, the radar system constantly learns about its surroundings and adopts its operational mode accordingly based upon the MI minimization criterion. Subsequently, the positioning algorithm makes use of this information about the radar scene to generate more accurate location estimates. Numerical results demonstrate an improvement in the probability of target detection even at low values of receive signal-to-noise ratio (SNR). The proposed algorithm also promises a better delay-Doppler resolution of the target, which can be analyzed through the radar ambiguity function (AF). Simulation data show an improvement in the target discrimination ability in the presence of noise and clutter. [C476]

"Scan-to-scan sea-spikes filtering for radar"

High range resolution radars are often a solution to the problem of small target detection in the presence of sea clutter, however this solution leads to a high density of sea-spikes echoes. The number of false plots can be very high and need to be regulated in order to be able to control the tracking load and limit the number of false tracks. In this paper a solution for the Coast Watcher 10 and Coast Watcher 100 products is derived. The new patented scan-to-scan algorithm used to filter plots before tracking is presented. It uses the position and Doppler information of the plots on several scans to regulate the number of false plots at tracking level. [C477]

"High range resolution DVB-T Passive Radar"

Passive Radar systems, also referred to as Passive Coherent Location systems (PCL), exploit reflections from illuminators of opportunity (IO) in order to detect and track objects. Digital waveforms like DVB-T and UMTS signals offer wide bandwidth channels which allow achieving good spatial resolution. Moreover, they have spectral properties which are nearly independent of the signal content. Such waveforms exhibit an ambiguity function with a thumb-tack shape and bandwidth that is constant in time. This paper focus on the usage of multiple channels of the same IO (e.g.: DVB-T or UMTS channels) in order to improve range resolution and make target recognition and radar imaging feasible. Specifically, two different architectures based on the exploitation of multiple DVB-T channels have been considered. A DVB-T transmission system has been simulated with a Simulink® model compliant to. Simulation results are presented and discussed in order to evaluate the system performance in terms of spatial resolution. [C478]

"Coherent LADAR range image for target recognition using Back-propagation neural network"

Range, intensity and Doppler images can be obtained by using coherent LADAR (laser radar). Range image is closely relative to physical structure property of target surface, and it can reflect essential characteristics of targets. At present the research on automatic target recognition technology for LADAR is attention-getting. The Back-propagation neural network (BPNN) has been used in multi-layered feed-forward adaptive neural networks, deserving special attention. In this paper, BPNN is introduced to recognize Vehicles on the ground with different carrier to noise ratio (CNR) of clutters, different orientations of target, and different distances between the object and sensor. The results of simulation show that the BPNN is feasible and effective for the target recognition. [C479]

"Comparison of target detection schemes in Doppler radar with PSK signals"

The aim of this article is to test the effectiveness of the known CFAR processors in order to detect moving targets in the frequency domain of real records. The purpose is to be chosen optimal CFAR detector for moving target detection. The data are obtained by portable, surveillance, Frequency Modulated Continuous Wave (FMCW) radar with Low probability of Intercept (LPI). In the paper are studied and compared CA, OS, SO, GO CFAR processors. [C480]

"A model-based track-before-detect strategy"

This paper addresses adaptive detection and tracking of a point-like target in thermal noise plus clutter which is assumed to be heterogeneous from one range cell to another. To this end, a track-before-detect scheme is derived and assessed; its design relies on autoregressive modeling of noise returns. A preliminary performance assessment, based upon Monte Carlo simulation, shows that it can outperform previously proposed TBD strategies. [C481]

"Odd-Symmetry Template based three-step detector for IR-UWB radar"

The detection scheme for robust detection and target location in the presence of interference is presented. The problem of detecting the slow-moving target at noisy background is addressed in this paper. A novel kind of Odd-Symmetry Template Correlation (OSTC) process is developed as the first-step of the detector. The OSTC method has a better performance due to interference suppression than traditional ones. The Range-Extended Constraint and Threshold Feedback technique is proposed as the second-step for detecting range-extended target and controlling the false alarm rate. The Multi-Cycle Fusion method completes the third-step detection procedure, and improves the detection reliability by reducing false alarms. Experimental results are given to demonstrate the efficiency of this approach. Moreover, the effectiveness of this method allows for real-time execution. [C482]

"An improved IPCP detector of UWB radar signals based on adaptive searching window"

The research on detection of range-extended targets has been a focus of UWB radars. The paper introduces weighted accumulation and adaptive searching to the IPCP detection, and theoretical value of detection threshold is derived in detail. Related experiment and simulation confirm that weighted accumulation increases SNR effectively and adaptive searching basically eliminates the negative effects on detection performance caused by unknown extended range of the target echoes, which guarantees the reliability and stability in practical application. [C483]

"A Data Fusion Algorithm for Marine Radar Tracking"

Automatic radar plotting aids (ARPA) and automatic identification system (AIS) are the most important navigational systems on board. ARPA is considered as the primary anti-collision system, but its detecting ability,

tracking accuracy and reliability are affected badly under the rough environmental weather condition. AIS provide steady and continuous navigation data come from GPS or DGPS with higher precision. In this paper, a data fusion algorithm has been developed for ARPA with AIS position data to improve its tracking accuracy and reliability. The proposed algorithm was experimented on a navigational radar simulator and a PC based platform programmed with VC++. The simulating results show that this method can effectively improve the accuracy and reliability of tracking. [C484]

"Receiver design to harness quantum illumination advantage"

An optical transmitter that uses entangled light generated by spontaneous parametric downconversion (SPDC), in conjunction with an optimal quantum-optical receiver (whose implementation is not yet known) is in principle capable of obtaining up to a 6 dB gain in the error-probability exponent over the optimum-reception un-entangled coherent-state lidar to detect the presence of a far-away target subject to entanglement-breaking loss and noise in the free-space link . We present an explicit design of a structured quantum-illumination receiver, which in conjunction with the SPDC transmitter is shown to achieve up to a 3 dB error-exponent advantage over the classical sensor. Apart from being fairly feasible for a proof-of-principle demonstration, this is to our knowledge the first structured design of a quantum-optical sensor for target detection that outperforms the comparable best classical lidar sensor appreciably in a low-brightness, lossy and noisy operating regime. [C485]

"Remote detection of aluminum and trace methane using mobile femtosecond laser system of T&T Lab"

We report two remote sensing experiments of aluminum in the winter time and trace methane in the summer time using the mobile femtosecond laser facility T&T (Terawatt & Terahertz) designed by the Defence R&D Canada-Valcartier (DRDC-Valcartier). This system is similar in many respects to Teramobile, the Franco-German laser system. In the first experiment, we demonstrated the feasibility of remote filament-induced breakdown spectroscopy of aluminum targets in an open field in the winter season of Quebec-city when the outside temperature was as low as -20degC. The fluorescence signals are detected in a LIDAR configuration with aluminum target located up to 60 meters. In the second experiment in the summer season, we remotely detected trace methane in the open field during daytime (with strong sun light) up to 20 meters. [C486]

"Study on Automotive Anti-collision Radar System and Its Signal Processing Algorithm"

Through analyzing the applied require for millimeter wave automotive anti-collision radar, we design the simple structure of radar system. For satisfying the demands of digital signal processing and dispatching affairs, the signal processor is designed by linking DSP and SCM. Considering the complexity of radar signal received, high efficient digital signal processing algorithms should be applied to radar. Useful targets can be detected in clutter through self-adaptive filtering, and the targets' distance/velocity can be measured through frequency domain pairing. So we introduce a signal processing algorithm through combining self-adaptive filtering with frequency domain pairing in order to get the targets' accurate distance/velocity information in clutter and multi-targets environment, and simulate the algorithm by computer. The simulation results prove that this algorithm is effective. [C487]

"MLE-based order statistic automatic CFCAR detection in Weibull background"

In this paper, we address the problem of automatic target detection in Weibull clutter and multiple target situations, without any prior knowledge of neither the non stationary clutter statistics in which the radar operates nor the number of outliers that may be present in the reference window. In doing this, we develop the forward and backward order statistic automatic constant false censoring and alarm rates detectors based upon the maximum likelihood estimator, MLE-based F/B-OSACDC-FCAR. The censuring and detection algorithms are a two in one built detector. They select repeatedly a suitable set of ranked cells among all reference cells surrounding the cell under test to estimate the unknown background level and set the adaptive threshold accordingly. The performance of these detectors is evaluated by means of Monte Carlo simulations. [C488]

"Information analysis in passive radar networks for target tracking"

In this paper, the amount of information that can be extracted from a passive radar network is analyzed based on Fisher information. The study aims to present a measure of performance for target tracking with respect to varying sensor numbers and geometry. Adequate number and geometry of receivers for different locations of ldquoilluminators of opportunityrdquo have been proposed to achieve an estimated target state with predetermined level of error. Additionally, tracking zones where tracking error can be sustained below a predetermined level have been established. Obtained results could prove useful while designing a passive radar network based on tracking accuracy requirements. [C489]

"GM-CPHD and MLPDA applied to the SEABAR07 and TNO-blind multi-static sonar data"

The Gaussian Mixture Cardinalized PHD (GM-CPHD) Tracker was applied to the SEABAR07 and to the ldquoblindrdquo TNO dataset from the MSTWG (Multistatic Tracking Working Group). The Maximum-Likelihood Probabilistic Data Association (MLPDA) batch tracker was applied to the TNO dataset only. The tracking results (plots and MOPs) are given. [C490]

"Bias correction using background stars for space-based IR tracking"

This paper proposes a methodology for removing sensor bias from a space-based infrared (IR) tracking system through the use of stars detected in the background field of the sensor. The tracking system consists of several satellites each equipped with a narrow-view IR sensor that provides bearing observations of the target. As stars are detected the instantaneous sensor pointing error can be calculated as the difference between star detection reading and the known position of the star. The system utilizes a separate bias filter to estimate the bias value based on these detections and adjust the target line of sight measurements accordingly. The target state is estimated through a linearized Kalman filter (LKF). Mean error results are given for the period when the target is in view of the satellite IR sensors. The results of this research provide a potential solution to bias correction while simultaneously tracking a target. [C491]

"Multiframe assignment tracker for MSTWG data"

In this paper, a multiframe assignment tracker is applied to the simulated data sets provided by the multistatic tracking working group (MSTWG). The multiframe assignment tracker solves the data association problem as a constrained optimization for fusing multiple sets of data to the tracks with an interacting multiple model (IMM) estimator. The challenges with these data sets are high false alarm rate, low probability of detection and multiple synchronous/asynchronous sensors. Multiframe data association is used to perform data association, which is the crucial part of the tracking. Centralized tracking is used to optimally fuse the information from multiple sensors. A track's status is updated using an m out of n logic rather than the track quality based logic that requires more accurate probability of detection values, which are not available and vary with time and geometry in the MSTWG data sets. The results obtained with the multiframe assignment tracker for all the data sets are given in the form of MSTWG performance metrics. [C492]

"Meta level tracking with multimode space-time adaptive processing of GMTI data"

Ground surveillance of the battlefield provides military analysts with information that is critical to the success of a mission; the type of the information includes the enemy force structure, enemy offensive combat formation, and maneuvering events. The conventional approach uses mainly the synthetic aperture radar (SAR) and electro-optical (EO) sensors to perform detection and identification of stationary targets on the battlefield. Ground moving target indicator (GMTI) radar with space-time adaptive processing (STAP), on the other hand, allows a more complete perception of the battlefield by adding the capability to detect moving objects over a large area. In particular, the simultaneous detection and estimation of angular location of a ground moving target via adaptive cancellation of ground clutter is demonstrated, where a single reflector antenna with a multimode feedhorn is used in a GMTI radar. Based on the GMTI radar output, we illustrate the use of stochastic parsing algorithm with stochastic context free grammar (SCFG) as an unifying framework for data association, target tracking, and situation awareness. [C493]

"Multiple dictionaries-based radar target identification via a likelihood ratio test"

Target identification has been an active researching area in past decades. In this paper, we present an iteration procedure to optimize the size of the undercomplete dictionary when multiple undercomplete dictionaries are used to characterize the scattering signatures of a complex target. Furthermore, we extend the signature reconstruction and decision criterion with only single undercomplete dictionary to the case with multiple dictionaries for a more practical target identification application. The proposed approach is compared with the matching-score criterion-based approach and single dictionary-based approach using measured signatures of three aircraft models in an ultra wide-band chamber. Results show that the proposed approach can provide more promising identification accuracy due to a more effective representation to the complex scattering behaviors. [C494]

"Digital signal processing method and implementation for pulse laser rangefinder"

The laser echo pulses of a pulse laser rangefinder are narrow, weak and low SNR (signal-to-noise ratio) signals. Digital signal processing method was presented for such signals to improve SNR. A digital signal processing

circuit of a pulse laser rangefinder was designed, based on DSP (digital signal processor) and CPLD chips. The algorithms of digital filtering, pulse accumulation, target detection and tracking are all implemented in the DSP chip. The CPLD chip was used to design the digital interface circuit. The experiments were completed and showed that compared with traditional pulse laser ranging method, digital signal processing method increased the SNR of echo pulse signal clearly, accordingly improved ranging ability of pulse laser rangefinder. At the same time, the high-speed DSP chip ensures real-time ranging. [C495]

"A three-layered architecture for real time path planning and obstacle avoidance for surveillance USVs operating in harbour fields"

The use of unmanned vehicles in the field of underwater and marine applications is increasing significantly in recent years. Autonomous vehicles (like AUVs and gliders) or teleoperated ones (like ROVs) are currently employed for executing a number of different underwater tasks, like inspecting submerged pipes, executing maintenance interventions on underwater gas- or oil-platforms, collecting environmental or oceanographic data, performing surveys on sites of archeological interest. In parallel with the development of underwater vehicles, unmanned surface vehicles (USVs), are they also witnessing an increasing interest from the robotic community, especially with the goal of performing surveillance applications, like patrolling and maintaining safeguarded against intruders harbours or other ldquocrucialrdquo sites. The potential benefits offered by automated vessels equipped with sensors such as cameras or sonars are quite evident, since they could be used to quickly identify the level of menace of unknown radar track without exposing any human operators to possible threats. However USVs, unlike in the underwater case, have to face the problem of avoiding other vessels which in most cases are manned ones. This is a crucial point especially in that kind of application, where the automated vessel has to move quickly towards a possible menace while at the same time avoiding all the other boats normally operating in the harbour area. Unfortunately, at the current state of art, a reliable methodology to avoid the other vessels and the availability of effective and accurate obstacle detection sensors is still missing. This paper focus its attention on the case of USV used for security applications within a harbour, devising a solution that can be real-time implemented for the obstacle avoidance problem under critical situations where the vehicle as to reach its target as fast as possible while guaranteeing the safety of the other vessels. The presented solution is based on-a three layered hierarchical architecture: the first layer computes a global path taking into account static obstacles known a priori, the second layer modifies this path in a locally optimal way (under certain assumptions) exploiting kinematic data of the moving obstacles, while the last layer reactively avoids obstacles for which such data is not available. The paper was therefore organized as follows: in the first section an introduction and state of art are presented, in the successive section the work discussed the first layer and the methods for the static obstacles avoidance, while in the third the paper focused on the moving obstacles and the proposed avoidance algorithm, while also presenting many different detailed simulation results regarding the performances achievable by the overall architecture. Finally a concluding section also indicate some still open problems and future work directions to be developed. [C496]

"New approach of imagery generation and target recognition based on 3D LIDAR data"

Light Detection and Ranging (LIDAR) sensor is an advanced technology of 3D-measurement with high accuracy. The processing of 3D point cloud data collected via LIDAR sensor is of topical interest for 3D target recognition. In this paper, a new approach of imagery generation and target recognition based on 3D LIDAR data is presented. The raw 3D point cloud data are transformed and interpolated to be stored in 2D matrix. The target imagery is generated and visualized by means of height-gray mapping principle proposed in paper. For different poses of target, the affine invariable moments of target imagery are selected as features for recognition because of its invariance in rotation, scaling, translation and affine transformation. BP neural network algorithm and Support Vector Machine (SVM) algorithm are utilized as method of target classification and recognition. The recognition results by two algorithms are compared against and analyzed detailedly. The new method had been applied into target recognition in outdoor experiments. Different types of targets are classified and the rate of correct recognition is greater than 95%. Through outdoor experiments, it can be proven that this new method is applied to the field of 3D target recognition effectively and stability. [C497]

"Target range profiling algorithm for airborne microwave sensor detection system"

The range profile is redundant and disordered because the sample interval time is less than transmitted pulse width. The accurate estimation and optimization of the target range profile are essential for realizing the airborne microwave sensor detection system. In this paper, an algorithm for the real-time estimation and optimization of the target range profile due to over-sampling is presented for the airborne stepped frequency pulse sensor system. Under the condition of over-sampling this new algorithm employs the FFT and optimization method to estimate and optimize the target range profile within antenna beam dwell time by using high speed DSP. Through the simulation of sensor data, the target range profile spectrum is measured and analyzed. The result of

simulation is that this new algorithm can reduce the effect of over-sampling on the range profile and obtain high resolution range profile of target. [C498]

"Search detection modeling and simulation for missile-borne high resolution radar"

Missile-borne high resolution radar search detection is a very important aspect in its signal processing flow, their modeling and simulation is an extremely necessary and basic work. In this paper, a coherent video signal simulation is applied to establish signal received model (i.e. antenna gain model, clutter receiver model, the target receiver model) and signal processing model based on missile-borne high resolution radar. Simulation is carried out and the results validate the efficiency. [C499]

"Tracking and imaging algorithm of walking human bodies for ultra wideband radar"

The Ultra WideBand(UWB) Radar used for detecting human bodies is a promising technique in many fields such as urban-warfare, counter-terrorism and calamity rescue scenarios. Conventional UWB imaging algorithm can not meet the demand in the capability of targets recognition and calculation efficiency. The SEABED Algorithm based on the reversible Boundary Scattering Transform (BST) can be used to fast reconstruct target shape, but its application is restricted because antenna are scanned to collect data, which is impractical for systems of detecting moving targets. In this paper, walking motion was used to replace antenna scanning by assuming a system model, and a novel algorithm based on SEABED for UWB radar systems is proposed. Simulation results show that the proposed algorithm features simple hardware requirement, low calculation, and high imaging precision, and it can also estimate the velocity, image and track walking human bodies. [C500]

"Effect of range ambiguity on space based AMTI clutter suppression and mitigation method"

Air moving target indication (AMTI) using space based radar (SBR) is attractive. In order to detect airborne target in clutter and measure the target's range at the same time, SBR usually use medium PRF waveform. Theoretical analysis and experimental results show that range ambiguity cause target's range ambiguity and clutter's range foldover. Range ambiguity significantly degrades the clutter suppression performance. A method based on orthogonal waveform for mitigating the range ambiguity effects is presented in this paper. The orthogonal waveform is launched in sequence. Then multi-channels matched filter is used to receive the replay pulse. Experimental results illustrate that the method is effective. [C501]

"OTHR impulsive interference detection in strong clutter background"

External impulsive interference (IMI) will severely degrade the performance of an Over-the-horizon radar (OTHR), and detection and suppression of IMI in strong clutter environment is the prerequisite for the target detection. This paper proposes a novel method based on the signal subspace properties, aiming at effectively detecting IMI with easy or without clutter suppression. Selective survey on median eigenvalues variation and discarding two largest eigenvalues can suppress clutter and simultaneously show peaks indicating the IMI position, which can be viewed as a joint clutter suppression and interference detection. Its operational performance is evaluated using experimental data from a high frequency surface wave(HFSW) OTHR system. [C502]

"Interpretation target pattern of a buried basic object on Surface Ground Penetrating Radar system"

Surface ground penetrating radar (GPR) is the one of radar technology that is widely used on many applications. It is non-destructive remote sensing method to detect underground buried objects. However, the output target is only hyperbolic representation. This research tries to enhance GPR capability by representing the visual/pattern of the detected target. GPR data of many basic objects (with circular, triangular and rectangular cross-section) are classified and extracted to generate data training model as a unique template for each type basic object. The pattern of object under test will be known by comparing its data with the training data using a decision tree method. A simple powerful algorithm to extract feature parameters of object which based on linier extrapolation is proposed. The result shown that tested buried basic objects can be correctly interpreted. [C503]

"Acquisition performance analysis of a synchronization scheme of DS/FH hybrid spread spectrum signals for TT&C"

A synchronization scheme of DS/FH hybrid spread spectrum signals based on fast frequency identification is proposed, for high dynamic characteristic of signals in TT&C system. On basis of providing the mathematical model of synchronization process of the signal, three-dimensional mean acquisition time expression as well as probabilities of detection and false alarm of acquisition system with PN phase error, Doppler frequency and AWGN, is derived. Based on numerical simulation of three-dimensional acquisition performance with the DSSS

mode of matched filter in time domain and multiple channels in frequency domain, impact of parameters of the signal and the acquisition system on acquisition performance is analyzed. Theoretical derivation and simulation results provide theoretical basis and practical reference for signal design as well as parameters selection of the acquisition system. [C504]

"Considerations on the validity constraints for the bistatic SAR processing"

This paper gives some considerations on the validity constraints for spaceborne/airborne configurations, based on Loffeld's bistatic formula (LBF) for unequal azimuth contribution of transmitter and receiver phase terms. [C505]

"Flexible ID association-based tracking algorithm"

For robust data association performance, tracking algorithms available in the literature utilize kinematic as well as non-kinematic information. These algorithms, however, do not provide a systematic way to utilize non-kinematic information to resolve severe and prolonged association ambiguities in the past. We propose a novel framework in which kinematic and non-kinematic information of potential targets are stored as different entities, respectively denoted as tracks and IDs. The dynamic association between tracks and IDs provides the mechanism for resolving past ambiguities and reporting any remaining ambiguity to the user. Simulation results are provided to show the effectiveness of the approach. [C506]

"Sidelobe comparison of golay and PRBS codes for subsurface radar applications"

Ultrawideband (UWB) radar is an evolving area of great interest with many potential defense and civilian applications. Broadly, UWB waveforms could be classified into non-random and random waveform categories; both nonlinear and linear frequency modulated (LFM) and typical coded waveforms fall in the former category, while random noise-like and pseudorandom noise-like waveforms are the examples of the latter. Since the waveforms transmitted by the radar systems can affect the target detection, accuracy, resolution, ambiguities, and clutter rejection, etc., there is a great interest to design and implement various transmit waveforms with predetermined criteria. [C507]

"Through wall ranging and imaging using UWB random noise waveform: System design considerations and preliminary experimental results"

In this work, a portable and real-time through-wall random noise radar is presented. The system is inherently covert and is immune from interference and jamming since a random noise waveform is used. By combining mature cross-correlation and SAR algorithm with FPGA-based receiver technology, the system is able to perform real-time range detection as well as imaging of targets, including human beings, behind a wall. [C508]

"Numerical and experimental verifications of digital correlator model for random noise radar"

Design theory and efficient digital correlator model of a random FM noise radar was presented. The correlator model was developed with System generator blocksets in Simulink environment to include the discrete time base and quantization effect if it can be implemented by using the FPGAs available in the markets. Numerical simulation was conducted with the virtual noise signal and moving target signal generators, and the obtained results show good agreements with the expected values. For an experimental examination, a mm-wave random FM noise radar was implemented based on the obtained design parameters, and a field test was made for detecting a high-speed moving target. With the logging data, an off-line correlation and Doppler processing was made, and the obtained information was very close to the estimated one again. All the results fully validate the design theory and the developed digital correlator model. [C509]

"Target Detection Using Radar with Dynamic Programming Approach"

Dim point target from an image sequence has been merged into the clutter. So the image has a low SNR and the detection of the dim point target under the low conditions becomes the sticking point. We introduce a novel tracking system based on dynamic programming algorithm (DPA). This algorithm can detect the dim point targets under the condition of low SNR. The dynamic programming technique can detect the trace of the point target which is moving with straight line and reduce the calculation amount. With the result of simulation test, it can be shown that the introduced algorithm can effectively detect moving point target trajectory in image sequences than previously developed algorithm. [C510]

"Research of Small Target Detection within Sea Clutter Based on Chaos"

In this paper, based on the prior knowledge of chaotic character of sea clutter, we discuss a method for detection of small target in sea clutter using neural network as a predictor. Neural network can capture the dynamics of strange attractor generating sea clutter. After the reconstruction of real-life radar data, BP and RBF networks are regularized, and then a set of sample data from real-life data is inputted into the networks to train the neural networks respectively. As a sequence, according the nature of neural networks, these trained networks could approximate the model of dynamical system responsible for sea clutter. These networks can be used to detect small target within sea clutter as a predictor. [C511]

"An Ultra-Wideband Radar System for Through-the-Wall Imaging Using a Mobile Robot"

High-resolution imaging through walls and other materials using microwave signals serves amongst other applications in the rapid detection of human maneuvering, rescue missions in collapsed buildings, and target feature extraction. While narrowband Doppler radar in the millimeter-wave or infrared spectrum can provide good resolution through clothing and packaging, penetration through denser sheetrock, plaster, and brick requires operation below 10 GHz; this band however yields poor resolution. As an alternative, Ultra-Wideband radar operating in this band boosts the bandwidth which translates into fine range resolution; still it requires an aperture length of several meters for comparable cross-range resolution. The associated cost and portability in realizing such an aperture through antenna arrays or fixed-length scanners have limited their lengths to the order of 1 meter in prototype systems to date. In this work, we propose a novel aperture taking form as a variable-length scanner or mobile robot. The wide dynamic range of our system coupled with its unrestricted aperture length allows us to generate high-resolution images up to a range of 8 meters or more. [C512]

"Combining ICA with LSSVM for Speckle Reduction of SAR Image"

Speckles are inherent defects due to coherent imaging principles in synthetic aperture radar (SAR) systems. An improved polarimetric SAR image filtering method based on ICA (independent component analysis) -LSSVM (least squares support vector machine) was developed to get better results for terrain classification, target detection and other applications. The first step of this method is to apply ICA to LSSVM for feature extraction. By using ICA, the original higher dimensional inputs will be transformed into other lower dimensional features, the regularized parameter and feature subsets will be geted,These new features are then used as the inputs of LSSVM to process a regularized procedure which defines a cost function to estimate true SAR image.Experiment results using polarimetric SAR data of ERS-1 satellite show that this algorithm attains good despeckling effect and preserves more valuable image details than traditional algorithms. [C513]

"New Velocity Dealiasing of Doppler Radar with the Interactive Method"

Doppler weather radar plays an important role for detecting and forecasting severe weather, it could probe atmosphere with high spatial and temporal resolutions. Because Doppler velocity ambiguity disturbs target recognition and data application, a lot of work focuses on velocity dealiasing. This research tries to study a new interactive method for unfolding the velocity ambiguity with the computer graphic function, which is quite different from the previous unfolding methods. The positive and negative areas of radial velocity are distinguished by zero velocity line in the radial velocity field which is easy to do with human's experience, then unfold process has been made in the selected area. This method needs not any extrapolation and hypothesis, could deal with one and more times velocity ambiguity. The result shows this unfold method is convenient and fast, and corrected information accuracy is ensured. [C514]

"A Heterogeneous Sensors Track-to-Track Correlation Algorithm Based on Fuzzy Numbers Similarity Degree"

In the distributed multi-sensor information fusion system composed of 2-D radar and infrared sensor, the problem of the track-to-track correlation is sophisticated because the types of the sensors are different and both of them donpsilat possess the consistent measurement space, this paper presents a heterogeneous sensors track correlation algorithm based on fuzzy number similarity degree. In this algorithm, each trackpsilas bearing information is considered as a discrete function of time, after performed temporal and spatial alignment, synchronizing the asynchronous bearing information of the track come from each sensor to the same reference time scale on the same coordinate system, the fuzzy number of each bearing information is calculated by using triangular membership function, the similarity degree between every two fuzzy numbers is calculated, then ,the similarity degreepsilas matrix of fuzzy number of bearing information is formed and the track correlation pairs are determined based on the similarity degreepsilas matrix .The results of simulation experiment show that this algorithm can effectively accomplish track-to-track correlation for the heterogeneous sensors consisting of radar and infrared sensor. [C515]

"Medium-high correlated Weibull-distributed clutter reduction by neural networks in coherent radar systems"

This paper presents a clutter reduction system when medium-high correlated Weibull-distributed clutter governs the environment of a coherent radar system. This proposal is based on the capabilities of learning of some artificial intelligence techniques, such as the neural networks. This capability of learning of the neural networks is used to learn some statistical characteristics of the radar environment. The results obtained with this proposal show how the desired signals (targets) are emphasized with respect to the environmental interference (clutter), which is reduced. Moreover, several advantages are found if it is compared with other classical approaches to reduce the clutter level, such as Target Sequence Known A Priori techniques. [C516]

"A review of radar techniques for ornithological observations"

This paper reviews some popular radar techniques involved in ornithological observations. Due to the biological properties of the observable targets, in order to collect correct signatures of the size, ground speed, height and wing beating information, most radar systems originally designed for meteorological detection require various upgrades and modifications, either in the hardware or software design process. Biological targets have relatively smaller Radar Cross Section (RCS) and greater variations in different species. The flying speed could be estimated by a Doppler radar. However, in order to distinguish species from each other, more information such as target altitude, flock patterns, even wing beating frequency have to be obtained from the radar signal processing. The aforementioned considerations and such related issues introduce new aspects and requirements to the radar system design. In the following section, we review various radar considerations in terms of different ornithological signatures. Emphasis is put on the pulse compression and dual polarization imaging techniques from the point of view of recent digital signal processing (DSP) implementation, which may be able to contribute to the advanced radar ornithology system design of the future. [C517]

"Detection of low-speed ground moving targets using MIMO radar"

Summary form only given. For airborne radar systems, space-time adaptive processing (STAP) is the approach that is normally adopted to detect ground moving targets in ground clutter, but the technique becomes less effective if the speed of ground moving targets is very low because of the proximity of the Doppler frequency of targets to that of ground clutter. Typical low-speed ground target detection scenarios include detecting ground troops and slowly-moving ground vehicles. Multiple-input multiple-output (MIMO) radar possesses multiple transmitting and receiving channels providing additional diversified reflections for fusion processing in target detection and measurements. MIMO radar has been extensively investigated, but the exact structure of MIMO radar is defined widely different. In this work, an innovative multi-level MIMO radar signal processing architecture is proposed for airborne systems to effectively detect low-speed ground moving targets. The new MIMO-based approach is demonstrated to be effective for detecting such low-speed ground targets in this work, and some simulation results are presented subsequently. [C518]

"Detection of moving intruders from a moving platform using a Ka -band continuous-wave doppler radar"

A scanning-beam Doppler radar has been presented which can detect moving intruders from a moving platform. The limitations of the scanning-beam sensor in terms of platform velocity and rotation rate were discussed for a fixed antenna beamwidth. Targets moving at any velocity relative to the platform can be detected, even when the person is moving along with the platform, producing no Doppler return. Estimation and removal of the clutter return was demonstrated in order to detect slow-moving targets whose response is within the clutter bandwidth. The optimal threshold value was determined using performance metrics for classifiers under imbalanced data sets. [C519]

"Tracking of metallic targets using a retro-reflective array at 26 GHz"

This paper presents a design concept to aid in the detection and tracking of objects in a cluttered environment. The goal is to uniquely identify large, relatively cylindrical metallic objects in a warehouse setting. In addition to the challenge of determining the object's precise location, it is also desirable to uniquely identify each cylinder. The application is similar to RFID but differs in that much longer range of operation is needed and operation on metallic objects is required. A planar Van Atta retro-reflector is used as the baseline for the RF tag with large angle-independent radar cross-section. [C520]

"The real world"

The mission of the Information Processing Techniques Office (IPTO) is to understand the world. From sensing to cognition, IPTO brings the future of computing to the warfighter. In a world where complexity and ambiguity reign, IPTO technologies lift the fog of war and enable timely, accurate decision-making. [C521]

"Use of prior information in active sonar tracking"

A Bayesian tracking model is proposed that uses measurement likelihood functions based on predicted signal-to-noise ratios (SNR) in active sonar data. The predicted SNR modeling can incorporate prior information, such as the presence of known discrete and persistent clutter objects. The likelihood model assumes an exponential distribution of returns with a mean based on the predictive model that incorporates assumed SNR of the targets, known clutter, and background clutter, and the beam response and waveform ambiguity functions. Two variations of an example based on simulated frequency modulated (FM) and continuous wave (CW) signals is used to assess target detection and localization performance. Significant enhancements are observed when prior knowledge of clutter is incorporated into the measurement model in these idealized examples. [C522]

"Using lateral length measurements in GMTI convoy tracking"

This contribution deals with tracking of convoys moving on ground by airborne GMTI radar. A technique based on generalized power estimators using multiple beams is used to estimate the lateral length component of an unresolved convoy. In combination with the conventional range measurement, the full length information can be obtained in case of a linear convoy. The main focus of this paper is the exploitation of this attribute information in order to improve the tracking process. The Bayes algorithm based on our earlier work is improved and incorporated into a JPDAF framework to deal with multiple targets. The processing of Doppler measurements is also included. Numerical results are presented based on a simulation scenario. [C523]

"Convoy detection processing by using the hybrid algorithm (GMCPHD/VS-IMMC-MHT) and Dynamic Bayesian Networks"

Convoys are military objects of interests in certain applications like battlefield surveillance, that is why it is important to detect and track them in the midst of civilian traffic as part of the situation assessment. Our purpose is a process in two steps. The first is an original tracking algorithm appropriate for ground moving target indicator (GMTI) data based on the hybridization of a labeled GMCPHD (Gaussian mixture cardinalized probability hypothesis density) and the VS-IMMC-MHT (variable structure-interacting multiple model with constraints-multiple hypothesis tracking): one is very efficient to estimate the number of targets and the other for the state estimates. Then, by using algorithm outputs and other data like video or SAR if they are available, vehicle aggregates are detected and their characteristic are introduced into a dynamic Bayesian network which processes the probability for an aggregate to be a convoy. Finally, the number of targets belonging to the convoy is evaluated. This process is tested on a complex simulated scenario, our tracking algorithm is compared to classical ones and used to compute the probability to have convoys. [C524]

"Target tracking in heavy-tailed clutter using amplitude information"

Harbor surveillance above and below the sea surface depends on sensors such as surveillance radar and multibeam sonar. These sensors attempt to detect and track moderately observable targets such as small boats or human divers in environments which often are characterized by heavy-tailed backgrounds. Target tracking in heavy-tailed environments is challenging even for moderately strong targets due to the more frequent occurrences of target-like outliers. One strategy for increased robustness is to use the backscattered signal strengths together with the kinematic measurements in the tracking method. This paper proposes two new amplitude likelihoods for target tracking in heavy-tailed backgrounds. The first likelihood works by incorporating the uncertainty of the background estimate. The second likelihood explicitly treats the background as heavy-tailed using the K-distribution. [C525]

"Performance-based sensor selection for optimal target tracking"

In current sensor management concepts sensor selection is usually based on the probability of detection of each sensor. Although this detection probability is based on certain environmental and sensor related parameters, it does not necessarily mean that the sensor with the highest detection probability also yields the best performance. A new sensor selection method was proposed for optimising the target tracking process that compares the available sensors by the best expected performance. This performance evaluation is based on the modified Riccati equation (MRE) and includes the detection probability and the sensor measurement accuracies. Also, different performance-based selection criteria are proposed, depending on the sensor task and the stage of a military operation. In this paper we allocate sensors for target tracking based on the outcome of the MRE selection algorithm and criteria. The results are compared with the current concept of selecting the sensor with

the highest probability of detection. [C526]

"Performance analysis of the Probabilistic Multi-hypothesis Tracking algorithm on the SEABAR data sets"

The probabilistic multi-hypothesis tracking (PMHT) algorithm is a batch type multi-target tracking algorithm based on the expectation-maximization (EM) method. Unlike other more popular methods (e.g., multi-hypothesis tracking, MHT) the computational burden of PMHT grows linearly in the size of the batch, the number of clutter detections, and the number of targets tracked. The SEABAR sea tiail was conducted by the NATO Undersea Research Center in 2007 to investigate the suitability of some experimental high gain deployed active sonar receivers for tracking underwater contacts of interest. The sea trial yielded several useful multi-static active sonar data sets. The purpose of the effort reported here is to assess the target tracking performance of PMHT using structured multi-static active sonar sea trial data collected during the SEABAR experiment. This study quantifies the effects of batch size on the ability of PMHT to hold track on constant velocity and maneuvering contacts to determine the values that provide acceptable tracking performance. Situations involving contact maneuvers or temporary loss of detection (a.k.a., drop outs) are of particular interest. Specifically, the ability of PMHT to hold track as a function of batch size for two multi-static active sonar sea trial data sets containing contact maneuvers and drop outs will be assessed. [C527]

"Performance of PDAF-based tracking methods in heavy-tailed clutter"

Harbor surveillance above and below the sea surface depends on sensors such as surveillance radar and multibeam sonar. These sensors attempt to detect and track moderately observable targets such as small boats or human divers in environments which often are characterized by heavy-tailed backgrounds. This paper provide simulation results which quantify the inevitable performance loss encountered in heavy-tailed environments. The results show that the performance loss can be reduced by accounting for heavy-tailedness in the detection and tracking processes, and by the utilization of Amplitude Information (AI). Two new amplitude likelihoods developed in a preceding paper come favorably out of this comparison. Furthermore, the evaluation of the Modified Riccati Equation (MRE) is outlined for the combination of AI and heavy-tailed clutter. The MRE can be used to decide the false alarm rate for the detection process preceding target tracking. [C528]

"Suboptimal JPDA for tracking in the presence of clutter and missed detections"

A new heuristic for data association on multi-target tracking systems is presented. The algorithm is based on the existing JPDA (Joint Probabilistic Data Association) algorithm, more specifically, on the Suboptimal JPDA approximation. However, compared to Suboptimal JPDA, the presented method exhibits a significant improvement on tracking performance for scenarios in the presence of clutter and missed detections, at negligible increase of computation cost. In fact, it approaches the performance of the classic JPDA, requiring, however, drastically lower computational resources. It is also be shown that the proposed method is more robust with respect to trajectory crossings than the original Suboptimal JPDA. [C529]

"Track-Before-Detect for sensors with complex measurements"

Track before detect (TkBD) is a paradigm that combines the target detection and estimation processes that are usually sequentially applied to sensor data in a conventional system. Under TkBD the single frame detector is removed and the tracker is supplied with the whole sensor image. Detection decisions are then shifted to the output of the tracker which is able to use temporal correlation to improve the decision performance. A fundamental measure used by most TkBD approaches is the likelihood ratio of the sensor data and this is formed as the product over individual cell likelihoods under the assumption of spatially independent noise. However, that approach exploits only the envelope of the known sensor point spread function. This article presents an approach for determining the data likelihood ratio that also includes phase information. This alternative likelihood ratio formulation is shown to both improve the discrimination of targets from noise and reduce the computation overhead of the algorithm. [C530]

"Likelihood Ratio Detection and Tracking"

Likelihood Ratio Detection and Tracking (LRDT) is an extension of Bayesian tracking that simultaneously estimates whether a target is present and its state if present. It is particularly suited to difficult detection and tracking situations involving low signal-to-noise ratios or high clutter density. LRDT extends the basic Bayes Markov single target recursion by adding a null state to represent the possibility of no target present. By converting to likelihood ratios, one obtains a recursion which is parallel to the Bayes Markov single target recursion and does not explicitly retain the null state as a separate state. This allows LRDT to use un-

thresholded or below-threshold sensor responses and to provide a natural and correct method of incorporating information from multiple sensors and disparate sensor types. LRDT performs incoherent integration of sensor responses over time by cumulating measurement likelihood ratios over possible target paths (tracks). When the cumulative likelihood ratio exceeds a specified threshold, a detection is called and a state estimate is extracted. LRDT is a recursive, Bayesian, Track-Before-Detect (TBD) system that does not require explicit association of sensor responses to target tracks. This allows LRDT to consider a vastly larger set of possible target paths than TBD systems based on multiple-hypothesis tracking or other track-based techniques. We give examples of the application of LRDT to (1) the detection of periscopes by surface ship radar, (2) the detection of submarines by multi-static active sonar, and (3) the automatic detection and tracking of acoustic sources by passive acoustic arrays. The similarity of certain forms of the LRDT recursion to those of the PHD and Multitarget Intensity filters is also discussed. We close by considering some non-traditional extensions of LRDT beyond classical detection and tracking such as monitoring the maritime supply chain to detect suspicious behavior. [C531]

"An assessment of hierarchical data fusion using SEABAR'07 data"

The results of processing selected runs from the SEABAR'07 multistatic sonar trials dataset through general dynamics Canada's multiple target tracker (MTT) hierarchical data fusion system are reported. The purpose of this exercise was to ascertain the performance potential of the MTT and, by inference, of hierarchical data fusion based tracking generally, against a real multistatic sonar scenario. Selected runs of the original SEABAR'07 dataset have proven themselves well suited to this purpose. Tracking results on these runs are quite positive. To compensate for the lack of a real target in these runs, the SEABAR'07 dataset also includes a modified version, in which the strong echo repeater returns have been replaced by much weaker returns computed using the basis bistatic target aspect model. Tracking results with this modified dataset proved less encouraging. These results suggest that the viability of multistatic sonar tracking using a hierarchical data fusion system like the MTT appears promising, but remains unproven; a calibrated trials dataset containing a real target is required to provide a definitive answer. [C532]

"Maximum likelihood approach to HF radar performance characterization"

As part of NURC maritime surveillance research activities, there is a need to characterize the performance of HF radar vessel-detection processing, in support of subsequent automatic tracking as well as fusion with other available sensor data. In particular, HF radar detection and localization performance for a given contact SNR threshold must be determined. This paper examines two approaches to do so: one based on the maximum-likelihood criterion, the other using a localization threshold on target-originated contacts. The differences in and merits of the two approach are discussed with simulated and real maritime HF radar data. We introduce a multi-stage track-extract-track approach to HF radar tracking that is effective in a heavily-cluttered environment. Finally, we introduce scalar information metric for sensor characterization and discuss its relevance to sensor selection and detection threshold determination. [C533]

"PHD filters for nonstandard targets, II: Unresolved targets"

The probability hypothesis density (PHD) and cardinalized PHD (CPHD) filters were introduced in 2000 and 2006, respectively, as approximations of the full multitarget Bayes detection and tracking filter. Both filters are based on the ldquostandardrdquo multitarget measurement model that underlies most multitarget tracking theory. This paper is one of a series of theoretical studies that address PHD and CPHD filters for nonstandard multitarget measurement models. In this paper I derive the measurement-update equations for a PHD filter that presumes a model for unresolved targets based on the concept of continuous target number. [C534]

"PHD filters for nonstandard targets, I: Extended targets"

The probability hypothesis density (PHD) and cardinalized PHD (CPHD) filters were introduced in 2000 and 2006, respectively, as approximations of the full multitarget Bayes detection and tracking filter. Both filters are based on the ldquostandardrdquo multitarget measurement model that underlies most multitarget tracking theory. This paper is one of a series of theoretical studies that address PHD and CPHD filters for nonstandard multitarget measurement models. In this paper I derive the measurement-update equations for a PHD filter that presumes a Poisson model for extended targets due to Gilholm, Godsill, Maskell, and Salmond. [C535]

"Optimal decision fusion in Through-the-Wall Radar Imaging"

We consider the problem of target detection behind walls based on optimum decision fusion using Neyman-Pearson tests. A framework, demonstrating the use of multiple sensor platforms and distributed detection for the emerging application area of Through-the-Wall Radar Imaging is presented. We derive the optimum decision rule at the fusion center for three dissimilar sensors and compare the corresponding target detection results to

that achieved when using a centralized decision approach. Real data generated using a two dimensional scanning system is used for the performance comparison. [C536]

"UWB Radar Sensor Networks Detection of Targets in Foliage Using Short-Time Fourier Transform"

First Page of the Article [C537]

"Compact UWB Probe for Near-Field Microwave Target Detection and Imaging"

The numerical analysis and experimental characterization of an ultra-wideband (UWB) probe designed for near-field target detection and imaging are reported. The configuration, based on transverse electromagnetic (TEM) horn, has two curved launching planes terminated with resistively loaded feedback loop and a U-shaped plane serving as the reflector. Resistive loads have been added to improve the performance at low frequencies in the UWB band. Numerical simulations and experimental measurements have been analyzed to assist with the characterization of the probe. It is demonstrated that the antenna exhibits a low return loss over a wide frequency range from 1 to 12 GHz. The spatial distribution of radiated energy is characterized in the frequency domain, using single-frequency radiation patterns in numerical simulations. A study of the target detection capability of the UWB probe is also included. The probe can be especially applied as the element in UWB radar-based detection and imaging systems. [C538]

"Experimental and electromagnetic simulation investigation of an Ultrawideband CPW-Fed Disc monopole antenna used through-wall detection and localization of targets"

Since the Federal Commission of Communication of the U.S.A. (FCC) has made available the ample spectrum in the band of 3.1 up to 10.6 GHz for Ultrawideband (UWB) technology for transmission of wireless data, many efforts in research and development has been made for the drawing and manufacture of UWB antennas. These types of antennas are used in a great variety of applications. As, for example, high speed wireless systems of communication, vehicle radars, monitoring, detection and localization, biomedical images, generation of images through walls, etc. This work has the objective of determining the performance of the coplanar waveguide-CPW Fed Disc monopole antenna through comparison experimental and of electromagnetic simulation of the parameters S11. The antenna, which has a band width of 7.5 GHz, consists of a rectangular conductor of height `h' of 47 mm, width `w' of 38 mm and radius of 12, 5 mm. At first, the antenna was drawn by simulation so that it fulfills the characteristics of an UWB antenna and on the second phase it was built to make possible to evaluate the real performance of the antenna while transmitting data in ultrawideband. [C539]

"TBD netted radar system in presence of multi false alarms"

Track before detect (TBD) in netted radar system in the presence of multi false alarms is proposed and studied. The proposed structure uses TBD algorithm based on Polar Hough Transform (PHT). This algorithm improves the detection probability of moving target along a straight line in conditions of multi false alarm. The advantage of the proposed approach is the data unification in a net of asynchronously working radars with different accuracy characteristics and each radar varied observation sampling period. The obtained simulation results illustrate the high effectiveness of this detector in the presence of false alarms. We study the detection probability of TBD multiradar system as a function of SNR and the false alarm probability for different radar number. The study is performed through Monte-Carlo simulations in MATLAB computing environment. [C540]

"Forward scattering indicatrix of aircrafts and possibility of over-the-horizon surveillance"

The scattering indicatrixes of targets in L and S bands for bi-static angles of (180plusmn55) degrees and a method of an aircraft beyond-the-horizon detection and estimation of its range and the cross velocity, when the aircraft crosses a propagation path, are discussed in the paper. [C541]

"Multistatic Passive Coherent Location radar systems"

The use of signals of opportunity such as television or radio signals to detect and track targets has cyclically entered and left technology fashion. However, due to high constraints in the receiver design, and the signal processing implementation in real time, operational systems have appeared only recently. This paper present a multistatic passive coherent location (PCL) system, where the signal, issued from several transmitters, is processed coherently by several receivers organized in a network configuration. An analysis of the signal processing operations is presented and an efficient hardware implementation is described. [C542]

"Feature Extraction of 2D Radar Profile via Double-Sides 2DPCA for Target Recognition"

Target recognition based on 2D radar profile is a rising application of radar technology, because 2D radar profile can offer more structural information about targets. But the methods of feature extraction based on 2D radar profile are very scarce. In this paper, a new approach double-sides 2DPCA is presented. It is performed by using original image matrices directly, while PCA always needs image matrices to be transformed into 1D vector. Besides, it can reduce the dimension of image from two sides and obtain a feature image with a much smaller size, while traditional 2DPCA, mainly used in the area of face recognition, can only reduce the size of image from one side. This approach has excellent dimension reduction property. The experimental results show that double-sides 2DPCA is effective on feature extraction of 2D radar profile and in much smaller dimension level, it has better recognition performance than traditional 2DPCA. [C543]

"Detection of Weak Signal in Chaotic Clutter Using Advanced LS-SVM Regression"

In this study, detection of small target in chaotic clutter with unknown dynamics is presented. We achieve this in four steps: (i) by using db3 wavelet decomposition of the signals, (ii) using Takens delay embedding theorem and least-squares support vector machine (LS-SVM) prediction, including increase the symmetric constraint and improve the kernel function, (iii) wavelet reconstruction, (iv) separation the weak signals from the prediction error. Efficiency of the new approach is evaluated by computing the root mean square error (RMSE) and signal-noise-radio (SNR) of the estimation. Lorenz attractor and the data from the McMaster IPIX radar sea clutter database will be used in the simulation. It is demonstrated in the simulation that compared with conventional RBF neural network LS-SVM regression prediction method; this approach has stronger generalization ability and better accuracy. [C544]

"An Algorithm for ISAR Ship Imaging Based on S-Distribution"

Under the sea wave, ship target experiences three-dimensional rotations and its echo Doppler frequency changes complexly. In order to improve the quality of ship image, a new algorithm based on S-distribution is proposed. The instantaneous ISAR image can be obtained by calculating the S-distribution of each range bin. In comparison with the classical time frequency distribution, S-distribution produces high concentration at the instantaneous frequency for arbitrary signals, its cross-term interference can be easily removed by recursive method, and its calculation is effective. The simulation results demonstrate the effectiveness of this imaging method. [C545]

"A New Type of Automatic Ship Detection Method"

A new type of automatic ship detection algorithm is proposed in this paper. By determining whether the local area is heterogeneous, simplex two-parameter CFAR algorithm based on Gauss-distribution or both two-parameter CFAR algorithm based on Gauss-distribution and two-parameter CFAR verification algorithm based on K-distribution are used to detect targets. This new type of algorithm keeps both the ability of traditional two-parameter CFAR algorithm' good features, such as small computation quantity, easy to implement and so on, and the detection accuracy in complex sea conditions at the same time. [C546]

"A Novel Method for Ship Detection Based on NSCT and ACO"

Ship detection is an important section of Synthetic Aperture Radar's marine applications. Through analyzing the distribution characteristics of ship targets and speckle, a novel ship detection method based on NSCT and ACO is proposed for SAR image processing. First, apply NSCT adaptive threshold method to de-noise the SAR images, then detect the edges by ACO, last ship targets can be precisely detected. Simulating results indicate that this method can not only pickup contour information of ship objects in complex speckle efficiently, but also keep ships structure well, show ideal antijamming competence, guarantee the detection accuracy. [C547]

"Maneuvering Target Tracking in the Case of Wakes"

An interacting multiple model probability data association method for tracking the wake target is presented. When the detections are fed to a tracking system like the probabilistic data association filter, the estimated track can be misled and sometimes lose the real target because of the wake. This problem becomes even more severe when the target performs maneuvering in the presence of wakes. To prevent this, we propose a probabilistic model of the wakes and deduce the new probability association coefficient, for the target's maneuvering, the interacting multiple model is applied. Simulation result shows, compared with the interacting multiple model probabilistic data association method, the new method could reduce the target loss effectively and retain low target loss ratio with augmenting measurement noise. [C548]

"A Heterogeneity-Based Ship Detection Algorithm for SAR Imagery"

Ship and wake detection from the SAR imagery have been studied for long time. In several situations, ship wake is not available for some reasons, such as sea status, the incidence angle of radar, and so on. Fortunately, ship always imaged in the radar image. In this paper a heterogeneity-based algorithm to detect ship in the open ocean is proposed. Firstly, a heterogeneity test is locally performed to detect the candidate target in the original image, and then a global optimal threshold is selected according to Renyi entropy to get rid of the false object. Thirdly, the segments of the same object for the noise present are merged according to its minimum distance to get the accurate position and number of the ships. Several real SAR images demonstrate its efficiency. [C549]

"Integrated clutter cancellation and high-resolution imaging of moving targets in Multi-channel SAR"

An integrated clutter cancellation and moving targets focusing scheme is presented for multichannel SAR (M-SAR) systems. The integration between the two processing steps is made feasible by performing the clutter cancellation processing in the Doppler frequency domain, and performing the moving target focusing by means of a bank of chirp scaling algorithms (CSA). The integration results efficient from a computational point of view, since the azimuth FFT is common to both the clutter cancellation and the focusing processing. The clutter cancellation step allows to achieve sub-clutter moving targets visibility. The bank of CSA filters, each one matched to a different along-track target velocity component allows to produce a high-resolution image of the target itself. The effectiveness of the proposed technique is shown with reference to a sample M-SAR dataset obtained from a SAREX-92 image. [C550]

"A multistatic radar array for detecting wild animals during pasture mowing"

During pasture mowing in spring time, every year countless animals such as fawns are killed or severely injured. In addition to animal protection laws, this is a big problem for farmers due to botulism of the livestock. Many different strategies have been developed to either scar the fawns away or to detect them, for example by searching with a hunting dog. These methods are either ineffective or very time-consuming and therefore less applicable. In this paper, we present a detecting method which is based on microwave signals. This incoherent radar system uses antennas arranged as a matrix and a signal superposition principle. It detects the reflection signature of covered targets of a certain shape-e.g. metals or objects with high water content. The low computing power needed allows a large area to be scanned within a short time. Since this radar system is almost completely insensitive to vertical movement of the extension arm, it can be mounted on a fast driving vehicle. [C551]

"Fast detection of moving targets by focusing in multi-channel Ultra-wideband SAR"

Long processing time and, in certain cases, restricted ability to detect moving targets are seen as the shortcomings of the moving target detection by focusing technique. The detection ability reduces significantly when Normalized Relative Speeds (NRS) with respect to the speed of the platform are approximated or equal to one. This paper propose solutions for such problems. Local Backprojection (LBP) replaces Global Backprojection (GBP) in the focusing approach of the detection method to save the processing time and a space-time processing technique, namely Displaced Phase Center Antenna (DPCA) is used to pre-process multi-channel SAR data to strengthen detection ability. Simulation results demonstrates a fast- and reliable detection achieved with these proposals. [C552]

"Comparison of Maximum Likelihood and Generalized Monopulse DOA estimation techniques on SOSTAR-X GMTI-STAP data"

The maximum likelihood (ML) angle estimator is widely considered the ldquooptimumrdquo angle estimator, particularly in presence of adaptive digital beam forming (ADBF). A number of papers in literature suggest several solutions to implement the bi-dimensional Doppler-azimuth angle ML estimation in a cost-efficient manner. Nickel demonstrated that the generalized monopulse technique can be derived from the ML technique just as a first order Taylor approximation of the ML estimator, at a minor implementation cost. This paper compares the results obtained by implementing the ML and the generalized monopulse techniques on the GMTI-STAP data gathered during the SOSTAR-X flight trials. [C553]

"Monitoring subsurface target changes based on cross-polarized wideband scattering"

In the context of resonance based radar target recognition, most work is done based on the co-polarized transient target signature excited by linearly polarized excitation. In this paper, the possibility of target recognition based on a cross-polarized wideband transient signature is investigated. Numerical examples of monitoring subsurface target-depth changes demonstrate that the cross-polarized transient target signature can also be

applied to these applications. In addition, for the first time, the possibility of applying the e-pulse technique together with cross-polarized target signature for monitoring geometrical changes of subsurface target is also investigated. [C554]

"Passive short range X-band frequency doubling transponder"

Various radar methods exist to identify and distinguish stationary and moving objects. Well known methods include synthetic aperture radar (SAR), millimetre-wave real aperture radar (RAR) and interferometric synthetic aperture radar (IFSAR) systems. In specific cases, one is interested to recognize a unique signal from objects. For example, in search and rescue operation radars, unique signals are identified from the Search and Rescue Transponder (SART) that is attached to the object of interest. However, unwanted clutter echoes can severely limit the detectability of the target. Clutter can be caused by obstacles, rain and surface reflections, is unpredictable and it cannot be easily removed. This paper presents the development of a low-cost, passive X-band transponder using frequency doubling to eliminate the problem of clutter. The passive transponder comprises of two rectangular patch antennas, a bandpass filter and a passive frequency doubler. Theoretical calculations show that such a passive transponder is able to operate at a range of about 1 km away from the radar. [C555]

"A ray tracing based method for coarse coordinate registration in HF skywave OTH radar"

Over-the-horizon (OTH) radars use the refractive properties of high-frequency radiowave propagation through the ionosphere for wide-area surveillance at long ranges. Target detection is accomplished by tracking returns in slant range, Doppler and azimuth. Moreover OTH radar performances are affected by several types of frequency dependent factors, mainly due to propagation and ionospheric absorption, but also related to the background noise. Coordinate registration (CR) is the process of localizing the target by converting the slant coordinates Rginto ground coordinates Rgrfor all the frequencies used in transmission. The CR method here presented is based on a ray tracing algorithm which provides the ground range distance reached with a specific transmission frequency and elevation angle. The ray tracing approach here adopted uses an electronic density profile estimated by using the latest revision (2007) of IRI (International Reference Ionosphere) model. Errors in the estimated down-range ionospheric parameters introduce as a consequence a degradation of target localization accuracy. The goal of this work is that to show a technique to determine the coordinate registration by jointly using ray tracing and Breit and Tuve theorem. [C556]

"Tracking of a move-stop-move target in clutter: A comparison among MM methods"

In this paper we compare three different sequential estimation algorithms for tracking a single move-stop-move target in clutter. Bayesian estimation algorithms are taken into account, with a special focus on particle filters (PF). The target can undergo three different motion modes: a stopped target mode, a constant velocity mode and a manoeuvre mode. We analyze a realistic car traffic scenario by considering not only additive Gaussian noise, but also detection probability less than unity and false measurements originated by clutter disturbance. The aim of this paper is to compare the so called PDA-MM-PF (probabilistic data association, multiple model, particle filter) and PDA-MM-APF (probabilistic data association, multiple model, auxiliary particle filter) to the well-established Kalmanbased PDA-IMM (probabilistic data association, interacting multiple model) tracking algorithm. Tracking filters ignore a priori information about the true clutter spatial density. Advantages and disadvantages of the proposed algorithms are illustrated and discussed through computer simulations. [C557]

"Evaluation of the tracking process in ground surveillance applications"

This paper discusses methods that are suitable for assessing the performance of target tracking algorithms. Emphasis is placed on applications involving ground moving targets detected by radar sensors, which are deployed on aerial platforms. Numerical examples are provided in relationship with an experimental ground moving target indicator (GMTI) tracker available at NC3A. [C558]

"Real-time software implementation of Passive Radar"

The paper presents a comparison of three different computing platforms for signal processing in Passive Coherent Location radar: general-purpose PC, Sony Play Station 3 and NVIDIA graphic card with CUDA technology. The radar under consideration was developed at Warsaw University of Technology, and it is called PaRaDe (Passive Radar Demonstrator). It utilizes commercial FM radio transmitters as illuminators of opportunity to detect and track airborne targets. In order to perform real-time processing, high computing power is needed. The aim of this paper was to investigate various solutions providing good performance at a reasonable price. [C559]

"Sub-Array Processing for parameters estimate of embedded conducting cylinders"

A hybrid electromagnetic-statistic approach for the detection and localization of buried perfectly-conducting circular cylinders is presented. The data used for simulating the scenario are produced by using the cylindrical wave approach (CWA) method. The inverse scattering problem is treated by means of a statistical detection technique. In particular, by the use of a SAP (sub-array processing) structure, it is possible to apply several algorithms of direction of arrival (DOA) estimation. By triangulating the DOAs, a set of crossings, condensed around the expected object locations, is obtained. To process the crossing pattern, we develop a statistical model for the crossings distribution, and employ hypothesis testing procedures to identify a collection of small windows containing targets. By defining a suitable threshold from a desired false alarm rate, and dividing the region in small windows it is possible to ascribe each window to the ground or to an object. [C560]

"Linear Sampling Method for time-lapse qualitative through-the-wall imaging"

The development of effective diagnostic tools for fast and non-invasive through-the-wall imaging (TWI) is an important topic, also motivated by the increasing public concern on security issues. In this framework, the main challenges are the detection of targets located on the other side of a wall and the monitoring of their motion. To pursue these aims, we propose an imaging strategy based on the linear sampling method (LSM), a computationally effective tool to determine the targets' morphology from multiview, multistatic and monochromatic data. In particular, by relying on the physical interpretation of LSM, we give its formulation for TWI and propose its use for motion tracking purposes by means of a simple post-processing strategy. A numerical example is given to assess the performances of the approach. [C561]

"Recent advances in waveforms for radar, including those with communication capability"

New scalable and flexible waveforms offer a great number of new opportunities for object- or environment-tailored signal processing. The paper will discuss two classes of such flexible waveforms, i.e. single carrier waveforms with orthogonal modulations and multiple carrier coded waveforms. These waveforms may for instance be used for the benefit of scalable resolution, fast unambiguous Doppler assessment, two-channel code-orthogonality supporting to measure the full back scatter matrix in radar polarimetry, and message transfer in a network by radar. [C562]

"Impulse based range-gated UWB wireless transceiver IC in 90nm CMOS for medical sensing applications and communications"

This paper presents a new impulse based ultra-wide band (UWB) transceiver system designed in 90 nm CMOS technology for UWB medical radar sensing and communication applications. The design is targeting for human heart motion detection and short range data communications. The transmitter is composed of a simple on-off keying (OOK) modulated impulse generator and a variable gain-controlled amplifier (VGA) at the transmitter. The generated pulse width can be adjusted. The receiver operating in the radar mode is composed of a simple low noise amplifier, a mixer, and an analog-to-digital converter operating in the radar mode. The range gate control design allows the receiver gather maximum power reflection from the objects within the expected range and minimizes the noise. The proposed impulse based UWB transceiver works under a 1.2 V power supply and the transmitter provides an output transmitting pulses of 300 mV to 50 Omega load. The fully integrated UWB transceiver occupies a core area of 0.3 mm2. The transceiver works in UWB band of 3.1-6 GHz and consumes an average power of 5.32 mW and 12.69 mW for simulations of radar sensing and communications, respectively. [C563]

"Target detection metrics and tracking for UWB radar sensor networks"

A radar sensor network (RSN) is a wireless network system, typically composed of one transmitting (TX) node and several receiving (RX) nodes, aimed at detecting and tracking an intruder (target) moving within a given surveillance area. In this paper, RSNs based on impulse radio ultra-wideband (UWB) are investigated. In the considered system, at each scanning each RX node calculates a soft image of the surveillance area based on the target-scattered UWB pulses. All images are then transferred to a fusion node where the decision about target presence or absence is taken. Optimum decision metrics and likelihood tests are developed, together with approximated metrics reducing the complexity of the detection block. Moreover, it is illustrated how the soft images produced by the RX nodes may be effectively exploited by tracking algorithms relying on Bayesian filters. [C564]

"An Improved Algorithm for Waveform Scheduling"

Cognitive radar can adaptively modify their performance to suit a variety of environments and select the best

sequence of waveforms to track the targets with higher possible accuracy. In this paper, based on the stochastic dynamic programming model of waveform scheduling, an improved algorithm for waveform scheduling is proposed. The simulation results show that the proposed algorithm can minimize the uncertainty of state estimation compared to fixed waveforms and approaches the optimal waveform scheduling scheme. [C565]

"Modified spin-image target recognition algorithm applied to laser radar range imagery"

We modify the spin-image matching algorithm to recognize targets in range images. It not only resolves the rotation-invariance problem existing in forward detection of laser radar (Ladar), but also meets a rapid target recognition requirement. [C566]

"Upper bounds on processing loss for wideband, long-CPI space-time adaptive processing"

The combination of synthetic aperture radar (SAR) and space-time adaptive processing (STAP) for moving target indication (MTI) radar applications allows the use of long, potentially sparse arrays, wide bandwidths, and long coherent processing intervals (CPIs), all of which enable detection of a greater variety of targets than is possible with traditional systems. In this paper, upper bounds on the signal-to-interference-plus-noise (SINR) loss are derived for post-SAR processing in the presence of three types of impairments: internal clutter motion, volumetric clutter, and antenna backlobes. These bounds are important for both the design and assessment of this type of MTI system, as impairments such as these can influence the entire system architecture. [C567]

"Subsurface object detection using UWB Ground Penetrating Radar"

Ultra wideband (UWB) ground penetrating radar (GPR) has been widely used in the detection of buried unexploded ordnance (UXO), particularly for small and/or shallow objects. Detecting subsurface objects from a weak reflection signal against strong clutter from GPR data is an important problem. A detection method which employs principal component analysis (PCA) and digital image processing techniques is proposed in this paper for clutter reduction in underground object location. The proposed method can robustly indicate not only the regular hyperbolas but also the perturbed slant lines as a result of buried objects. Experimental data collected using an UWB GPR system is used to demonstrate that the proposed methods are effective in reducing clutter and detecting subsurface targets. [C568]

"Low Bit Rate ROI-Based SAR Image Compression"

Due to large amount of collected data, image compression is both necessary and important for SAR system. Conventional image compression algorithms are incapable of attaining the desired compression while retaining the image fidelity required for processing at the ground station. In this paper, we present a ROI-based SAR image compression system for low bit rate. Region of interest is identified by a multiresolution constant false alarm rate (CFAR) detector and it is encoded with a higher bit rate than background. Performance was tested over the public MSTAR target chips. Results show that SNR of target area with proposed algorithm are higher than that with conventional algorithm and contextual information is preserved. [C569]

"A robust W-MUSIC algorithm for GPR target detection in the presence of noise"

When applied to ground penetrating radar (GPR), the multiple signal classification (MUSIC) algorithm is an important frequency estimation method as it can detect very closely spaced targets, particularly when one of the target responses is substantially lower than another. The MUSIC algorithm however must be seeded with the number of targets to find and will indicate that number of targets regardless of the number of targets actually present. In the presence of relatively low levels of noise the MUSIC algorithm is prone to reporting the position of false targets in preference to weaker genuine target responses. In this paper a superimposed MUSIC technique is proposed to suppress false targets. A novel windowed FFT MUSIC (W-MUSIC) algorithm is examined using a linear sweep frequency in noise. It is seen to give a clear indication of targets in the presence of modest noise that prevents MUSIC from working. [C570]

"Likelihood adjustment among multiple targets for particle dependent tracking in particle filters"

A problem arising at multiple target tracking with particle filters typically in vision has been claimed and a likelihood adjustment method has been proposed. First, classify tracking methods by particle filters into two categories, detection first tracking and particle dependent tracking. Then this research focus on the particle dependent tracking. It involves the problem in case of multiple target tracking that difference of likelihood among target leads to unintended convergence of particles to one target. This is a phenomenon in particle filters that particles prefer easier target having large likelihood value than the difficult target to track having small likelihood value. To overcome this problem, the author proposes to adjust the likelihood among the targets by taking

difference in log-likelihood to local maximum of them in each target. Performance of the proposed method has been shown in visual target tracking experiment based on color region. [C571]

"Optimal waveform precoder design for narrowband MIMO radar systems"

This paper addresses the problem of coded waveform design for Multiple Input-Multiple Output (MIMO) radar systems. The paper proposes a signal model based on the assumption of a small array aperture relative to the signal wavelength and a single target in far field. It is argued that near maximum likelihood performance can be obtained by choosing the transmitted waveforms on different antennas to be orthogonal. The Cramer-Rao Bound (CRB) for estimating the target distance, radial velocity and wavenumber is derived. The paper presents a convex optimisation procedure to yield an optimal energy distribution across the transmitted signals. Simulations demonstrate a reduction in CRB in the order of 25% compared to the use of a random unitary code. The paper concludes by indicating a natural generalisation of the method to optimal design for MIMO tracking radars. [C572]

"Multiresolution Target Detection in Wavelet Domain for SAR Imagery"

Multiresolution CFAR detection algorithm in wavelet domain using db4 wavelet is investigated in this paper, which can be incorporated into SAR image compression system. It is derived on a multiscale model of SAR imagery. Thanks to the structure of this model and detection in wavelet domain, calculation is much simpler than that of two parameter CFAR detection algorithm in image domain. Tests on simulated and collected image show that the proposed algorithm performs best. The algorithm is more suitable for the application in ROI-based image compression than two parameter CFAR detection algorithm in image domain. [C573]

"Adaptive MIMO radar detection in non-Gaussian and heterogeneous clutter considering fluctuating targets"

Previously, the Generalized Likelihood Ratio Test-Linear Quadratic (GLRT-LQ) has been extended to the Multiple-Input Multiple-Output (MIMO) case where all transmit-receive subarrays are considered jointly as a system such that only one detection threshold is used. The new MIMO detector is Constant False Alarm Rate (CFAR) with respect to the clutter power fluctuations. In this paper, the adaptive version of this detector is considered, as well as a fluctuating target model similar to that of the Swerling Target. The degradation of the detection performance due to the estimation of the covariance matrix and the fluctuation of the target is studied through simulations for both the well-known Optimum Gaussian Detector (OGD) and the new MIMO detector under Gaussian and non-Gaussian clutter. [C574]

"Performance analysis of DOA estimation for MIMO sonar based on experiments"

In this paper, a Multiple Input Multiple Output (MIMO) monostatic sonar scheme that can deal with multiple targets is presented, where orthogonal waveforms are transmitted simultaneously. Meanwhile the Capon estimator for this sonar system is derived in detail. And the performance of the MIMO sonar is analyzed via experiments in an anechoic water tank, as compared with its phased-array counterpart. The used sonar array is a uniform linear array with 10 closely spaced elements. Experimental results show that, by orthogonal transmit, this sonar system could achieve 12~15 dB additional array gains over its phased-array counterpart, which means the maximum detection range could be doubled; also, the angle resolution capability could be significantly improved at lower SNR. [C575]

"Improved Background Prediction Algorithm for IR Small Targets Detection"

For detection problem of infrared dim small targets in complex background, an adaptive filtering algorithm based on the improved M-estimation is put forward to suppress background clutter. In the proposed algorithm, target pixels and observed noise form the mixed interference of background estimation. In order to better estimate the background, the proposed algorithm introduces the correction factor to reduce the influence of target pixels and introduces the forget factor to entreat the non-homogeneous backgrounds. The experimental results to real images show that the proposed algorithm can better suppress background and preserve target information than the commonly-used median filtering algorithm and the LMS filtering algorithm. As a result, the proposed algorithm can detect effectively IR small targets in complex background. [C576]

"Study on the Differences of the Dynamic Target Information of the Marine Radar and AIS"

Both radar and AIS (automatic identification system) are the most important navigational equipment for a ship. But, there are some differences between them in the performance and the target information. The paper studied the difference and characteristic of the dynamic target information from the radar and the AIS. Based on the

survey platform of the target information system developed by the own, measurements were vastly done for the target's dynamic information, including position, speed and course. It evaluated the differences between them, and got the very important statistic results. It offers not only the valuable references for the voyager to understand and identify the target information characteristic, but also the research foundation of the information processing such as target information fusion, and the intelligent ship collision avoidance and so on. [C577]

"Application of Radar Signal Processing System Based on DSP in the VTS"

Radar signal processing system is an important part of vessel traffic services. In order to overcome the shortcomings of traditional analog video system, this paper proposes a design solution for digital radar signal processing system based on DSP and a new method that is a constant false alarm rate algorithm based on wavelet transform. This method can suppress the interference of sea clutter without impairing the target resolution. Experimental results demonstrate this system can increase the detection accuracy and reduce the false alarm rate. Furthermore, the tracking performance can be improved. Radar signal processing system based on DSP plays an important role in the vessel traffic services. [C578]

"A Kind of Signal Processing Method for the Polarization Phased Array Radar"

This paper discusses a kind of polarization phased array radar system and its signal processing method. The polarization signal processing technology is introduced to improve the detection performance and anti-jamming ability of the radars. In order to achieve the performance of low probability of intercept (LPI) for the transmitted signal, the linear frequency modulation (LFM) is adopted inside each pulse and the frequency coded technology is adopted among pulses. The radar system can received the scatted signal of the target through dual polarization channels simultaneously and the polarization information of the target scatted signal can be obtained. In signal processing, the polarization parameter estimation and polarization detection technology are used. The basic structure of the polarization phased array radar is introduced, and the specific LFM pulse compression and polarization detection method are discussed. The analysis results in this paper can provide a reference for the design of the polarization phased array radar. [C579]

"Target Detection in SAR Image Based-on Wavelet Transform and Fractal Feature"

This paper introduces a small target detection algorithm combined with wavelet transform and high-order fractal feature for SAR image. The new algorithm is composed of three steps:(1) decompose the original image using wavelet transform and (2) extract the wavelet coefficients in low frequency and calculate its high-order fractal parameter to judge the target region, and (3) inverse wavelet transform to obtain the result image. Results are presented for two fractal methods (high-order fractal feature and fitting error).Our analyses show that the effect of using high-order fractal feature is better than fitting error. Based on the experiment result available to us, the small target is detected exactly from the SAR image. [C580]

"Adaptive Pulse Regulations to Achieve High Range Resolution within the Unambiguous Window"

In this article, we consider a kind of high resolution radar system with adaptive pulse adjustment for target detection and locating. There exist a trade-off between the ambiguity range distance and the resolution, we adaptively regulate the carrier spacing to make the ambiguity range window large enough to contain all target extent with a specified DFT size. Doppler shift and the target moving velocity is considered for target range resolution. We also present the critical value for each sub-pulse sequence to quickly obtain all scatters. The waveform at the receiver side after low pass filter and IFFT procedure is shown to illustrate the effectiveness of the proposed approach. [C581]

"A Modified Dynamic Programming Approach for Dim Target Detection and Tracking"

Dynamic Programming (DP) algorithm based Track Before Detect (TBD) is an efficient approach to detect the dim moving target. However, the big computational burden is the disadvantage of DP algorithm, which restricts its applications in many fields, such as radar detection where the real-time processing is a necessary requirement. A modified DP algorithm has been developed in this paper. The main idea of this algorithm is that a low threshold is applied to the measurement frame before DP processing. Its computational requirements and detection performance are analyzed and compared with traditional DP. Simulation results show that it can produce an order-of-magnitude reduction in computational demand with only about 1 dB detection performance loss. And more processing reduction can also be achieved, consequently, with more performance loss. Thus, this algorithm offers an approach of tradeoff between computational reduction and performance loss in DP processing. And by this kind of tradeoff, the real-time DP processing can be realized with acceptable performance loss in many fields. [C582]

"Application of ASAR PSI techonology to ground deformation detection in mega-cities of the Pearl River Delta Region in China"

In this study, we present the application of Persistent Scatterer Interferometry (PSI) technology with ENVISAT (European satellite) Advanced Synthetic Aperture Radar (ASAR) images to detect the ground deformation in the Guangzhou urban area and Hong Kong International Airport (HKIA). A map of ground deformation rates in Guangzhou with scattered points shows that the maximum subsidence (rise) rate is up to -26 to -20 mma-1(16-21 mma-1), implying the study area as an active zone of the ground deformation. Based on the point targets, a contour map of ground deformation rates was then generated. The map indicates that three major subsidence zones are located in the middle-west, east, and southwest of Guangzhou urban area, respectively. Six ground collapse accidents that occurred in Guangzhou during 2007-2008, within these subsidence zones, qualitatively validated the results. In the case of detecting ground deformation in HKIA, the ground truth data provided by the Airport Authority Hong Kong were used to correct the model, which is then applied to analyze the systematic errors existing in ASAR PSI-detected ground deformation rates. 2250 corrected ASAR PSI-detected points of annual ground deformation rates were used for the statistical analysis. The obtained results agree the Gaussian distribution well in our case studies. [C583]

"Analysis of ground deformations based on parallel geostatistical computations of PSInSAR data"

The ground deformations can be caused by many different factors. One of them is coal exploitation. It can cause not only strong and abrupt ground movements but also small, long period deformations which can occur even several years after exploitation is finished. In both cases these displacements are serious menace for surface and subsurface infrastructure. In this work the PSInSAR data were used to study small, long lasting ground deformations which occurred in the Upper Silesian Coal Basin (south Poland) in the years 1992-2003. In this region the intensive coal exploitation has been carried on. Additionally this area has complicated geological structure. These factors make studied region particularly threatened with terrain deformations. The subsidence phenomenon was detected in this region using PSInSAR method. PSInSAR technique is a dynamically developed branch of satellite radar interferometry. It exploits a set of dozens satellite SAR images in order to detect small ground deformations for large areas. PSInSAR technique derives information only about ground movements for stable radar targets, so called PS points. They correspond with man-made features on the ground like buildings, bridges etc. In the Upper Silesian Coal Basin the values of ground deformations were measured for more then 120000 PS points. Their location is very irregular. In order to study the origin of this ground displacements the values of deformations have to be estimated in no-observed locations. In this work this estimation was performed using kriging which is a geostatistical method of interpolation. It is very computationally expensive method because it requires the solution of a large linear system for each grid node in which the interpolation is done. Because the PSInSAR dataset is very large the kriging computations were done in parallel environment. In the designing of the parallel kriging algorithm also strong irregularity of PS points location was taken into consideration. At the-beginning of the formulated parallel kriging algorithm, the number of PS points used in grid nodes interpolation was determined. Then, based on this information, data decomposition was conducted. In this process, grid points were divided between CPUs, so that each processor had the same number of calculations to perform. This solution is optimized for PSInSAR data points, which are deployed irregularly, often in local centers on the research area. It was shown in this work that geostatistical methods can be successfully used in PSInSAR data analysis, but are computationally expensive. By designing parallel kriging algorithm for PSInSAR data and using Blade infrastructure for computations, it was possible to conduct the interpolation of ground deformations in viable time. It is worth to underline the universality of this algorithm, which can be used not only for PSInSAR data, but also for other types of data with similar characteristic. [C584]

"Errors of target detecting using triangulation method in radar with phased antenna array"

In this paper a study of spatial beam pattern of electrically scanning antenna arrays in order to obtain the curve of a bearing error versus the height of bearing targets in the azimuthal plane in the cases of different ranges. [C585]

"Multiscale Orientation and Recognition for Permanent Scatterers"

How to effectively detect and identify permanent scatterers (PS) from SAR images is one of the crucial procedures in PS interferometric system. In this paper, a new method of PS detection is presented by using the wavelet multi-scale product and wavelet modulus maxima according to the PS targets' features and the characteristics of speckle noise in SAR image. This paper analyzed the theory of wavelet multi-scale product and wavelet modulus maxima and its suitability for identifying PS points respectively. Using 4 SAR images over Nanjin from satellites ENVISAT of European Space Agency, both of the methods have been validated for PS detection. The testing results show that both the two algorithm can identify PS from SAR images effectively and

reliably. Of which the method using wavelet modulus maxima has stronger anti-noise ability. [C586]

"RCS measurements and predictions of different targets for radar benchmark purpose"

This paper presents radar cross section (RCS) measurements of different targets suitable for electromagnetic software comparison and validation. The targets have been designed, fabricated and measured at INTA to study different scattering mechanisms such as reflection and diffraction on curved surfaces and edges (truncated cone), reflection and diffraction on planar surfaces and straight wedges (triangular prism) or tip diffraction and travelling waves (conesphere). These measurements can be used as a valuable tool to validate and adjust the input parameters of electromagnetic prediction codes according to the requirements of the engineer. [C587]

"A through wall UWB RADAR with mechanical sweeping system"

This paper presents a UWB radar system with mechanical scanning. The advantages of UWB technology for radar are exposed, followed by a description of the mechanical scanning system. Finally, we use image processing to detect a target through a wall. We measure the impact of the radiation pattern of two antennas to improve the cross-range resolution. [C588]

"Ground moving personnel indication and tracking from airborne platforms"

Radar is valued for its ability to surveil large areas, day and night, in all weather conditions, with high revisit in order to provide detection and tracking of individuals and groups. Such radars operate either stand-alone or while networked and may generate cues for EO/IR sensors for identification and classification. In the security applications domain radar basing or siting has been predominately, if not exclusively, from fixed, ground-based positions (this includes mobile systems that must be stationary when employed). Airborne radar systems employing phased array antennas and advanced adaptive processing are investigated for their ability to detect and track individuals, in a security application, when integrated with small and medium unmanned air vehicles. Airborne surveillance radar overcomes many of the visibility issues of ground-based systems by operating at steeper grazing angles. We evaluate performance for two operating altitudes and in a variety of surface wind conditions, demonstrating high probability of detection against walking human targets. These results suggest the viability of UAV-based airborne radar as candidates for future surveillance architectures. [C589]

"Ellipse-cross-localization accuracy analysis of through-the-wall radar"

Ellipse-cross-localization (ECL) method is presented for TWR location in this paper. The location error is mainly influenced by errors of the wall parameters and the target relative position to antennas. The effect of wall thickness and dielectric constant on TWR localization is analyzed. And the localization accuracy of detection region in different antennas configurations is illustrated by location error distribution map. The results demonstrate that accurate estimation of wall parameters and proper configuration of antennas can improve the performance of TWR system efficiently. These lead to new insights on TWR system design. [C590]

"Response of polar format algorithm to moving target with consideration of wavefront curvature"

The synthetic aperture radar (SAR) signatures of moving target are the basis of ground moving target detection and imaging (GMTI&Im). However, previous studies are mainly focused on the influence of target's motion on phase history; and little work has been done to investigate the signatures of moving target after the application of a particular SAR image formation algorithm. In this paper, we derive the image spectrum of moving target after polar format algorithm (PFA) processing. Based on this image spectrum, detailed analysis on the SAR signatures of moving target, including the geometric displacement, residual range migration, range and azimuth defocusing are performed. Simulation results validate the theoretical analysis. [C591]

"Iterative target detection approach for Through-the-wall Radar Imaging"

We consider the problem of target detection in Through-the-wall Radar Imaging when no a priori knowledge about the image statistics is available. An iterative approach which adapts itself to the unknown image statistics and thus allows for automatic target detection is presented. Two variants, based on 2D median filtering and morphological operations, are described in details. The proposed detection schemes are tested using experimental data, considering the problem of 3D reconstruction of a scene hidden behind a concrete wall. [C592]

"MIMO radar angle-range-Doppler imaging"

Through waveform diversity, multiple-input multiple-output (MIMO) radar can achieve higher resolution and better

sensitivity to slowly moving targets than phased-array radar systems. Furthermore, with a MIMO antenna array, the linear independence of reflected signals from scattering points allows for the direct application of adaptive array processing techniques. High levels of noise and strong clutter presence, however, significantly worsen detection performance. The iterative adaptive approach (IAA), a non-parametric and user parameter-free weighted least-squares algorithm, was recently shown to offer improved resolution and interference rejection for array processing applications. In this paper, we extend IAA to perform angle-range-Doppler imaging using a MIMO radar system. We furthermore demonstrate the superior performance of a MIMO radar system compared to a single-input multiple-output (SIMO) radar system. [C593]

"Three-dimensional human imaging for through-the-wall radar"

Three-dimensional imaging can provide more detail information of the target than two-dimensional image, which can be used to identify the target. Thus, it is very useful for detecting in enclosed structures or behind the obstacle. This paper mainly research on the three-dimensional through-the-wall human imaging and introduce an approximate method to calculate the propagation delay when electromagnetic wave passing through the wall. The refraction point can be computed directly by specific rule rather than searched the solution of complicated transcendental equation. We will design the experiment to validate the proposed method. [C594]

"Bistatic SAR using illumination from a tethered Ground Moving Target Indication Radar"

In order to limit the ground clutter obscuration of very slow moving targets, ground moving target indication (GMTI) radars can be operated from stationary platforms. These systems generally cannot detect stationary targets for surface target surveillance. However, by using a small unmanned air vehicle (UAV) as a bistatic adjunct to GMTI system, a synthetic aperture radar (SAR) image can be formed. Modeling of bistatic SAR with a stationary transmitter was carried out to determine limitations on waveform and receiver platform operational parameters. [C595]

"Reduced-complexity delay-Doppler correlator for time-frequency hopping signals"

The delay-Doppler correlator is most commonly used for target detection in a radar system. It is essentially a two-dimensional filter matched to the hypothesized delay and Doppler shifts of echoes reflected from the illuminating signal. More recently, it has been applied in communication to the detection of signature sequences generated from artificially introduced time-frequency shifts of a base sequence. In this paper, we derive a computationally efficient delay-Doppler correlator for a class of time-frequency hopping waveforms that can be represented by segments of equal-length sinusoids. These sequences can be found in applications such as continuous waveform radar and device identification in wireless communication. By applying sliding discrete Fourier transform and exploiting the structure of the waveform, the number of multiplications required for evaluating the entire delay-Doppler range can be reduced by a factor equaling the length of the sequence. [C596]

"Joint MIMO radar waveform and receiving filter optimization"

The concept of MIMO (multiple-input multiple-output) radar allows each transmitting antenna element to transmit an arbitrary waveform. This provides extra degrees of freedom compared to the traditional transmit beamforming approach. It has been shown in the recent literature that MIMO radar systems have many advantages. In this paper, we consider the joint optimization of waveforms and receiving filters in the MIMO radar when the prior information of target and clutter are available. A novel iterative algorithm is proposed to optimize the waveforms and receiving filters such that the detection performance can be maximized. The proposed algorithm guarantees that the SINR performance improves in each iteration step. The numerical results show that the proposed methods have better SINR performances than existing design methods. [C597]

"Spatio-temporal adaptive detector in non-homogeneous and low-rank clutter"

Reducing the number of secondary data used to estimate the Clutter Covariance Matrix (CCM) for Space Time Adaptive Processing (STAP) techniques is still an active research topic. Low rank CCM estimates have already been proposed but only for homogeneous and Gaussian clutter. We propose in this paper to extend the low-rank CCM methods for heterogeneous and/or non-Gaussian clutter. We derive a new detector based on low-rank techniques and exploiting properties of the Normalized Sample Covariance Matrix (NSCM). This detector is shown to exhibit a smaller SNR loss than classical STAP detectors. Moreover, the new detector has a texture-CFAR property with respect to non-Gaussian SIRV model and has more robust behavior when some targets are present in the secondary data. We also give experimental comparison results between the classical STAP detectors and the new one for STAP data. [C598]

"Space-time-range three dimensional adaptive processing"

Space-time adaptive processing (STAP) is an effective tool for moving target detection. Conventional STAP methodologies process the angular and Doppler two dimensional data vector. In practical applications, adjacent range cells are statistically dependent due to filtering, since the point spreading function of a target is not an ideal delta function. In this paper, a novel approach incorporating range (fast time) information in STAP is presented for clutter rejection, which we term space-time-range adaptive processing (STRAP). This method takes advantage of the correlation information of neighboring range cells. Therefore, the stationary clutter can be suppressed better compared with traditional STAP algorithms ignoring fast time information, resulting in more effective moving target detection. The validity of the STRAP algorithm is verified by the experiments of processing the real measured data of the three-channel X-band radar and MCARM radar systems. [C599]

"New polarimetric signal subspace detectors for SAR processors"

This paper deals with three new polarimetric SAR processors based on subspace detectors. These algorithms aim at using models with physical and polarimetric scattering properties not exploited by the isotropic point model. These processors are implemented by computing the corresponding target subspaces. Results on simulated data with realistic targets show the interest of these new processors. [C600]

"Optimal and robust waveform design for MIMO radars"

Waveform design for Target identification and classification in MIMO radar systems has been studied in several recent works. While the previous works considered signal independent noise, here we extend the results to the case where signal-dependent noise, clutter, is also present and then we find the optimum waveform for several estimators differing in the assumptions on the given statistics. Computing the optimal waveforms for MMSE estimator leads to the Semi-definite programming (SDP) problem. Finding the optimal transmit signals for CSLS estimator results in a minimax eigenvalue problem. Finally it is shown that equal power waveforms are the best transmit signals for the SLS estimator. [C601]

"A PARAFAC-based technique for detection and localization of multiple targets in a MIMO radar system"

In this paper, we show that the problem of detection and localization of multiple targets in a bistatic MIMO radar system can be solved by parallel factor (PARAFAC) analysis. Our method is deterministic and fully capitalizes on the strong algebraic structure of the received data, where the radar cross section (RCS) fluctuation is not regarded as a nuisance parameter but rather as a source of time diversity. Simulation results show that our technique outperforms existing beamforming-based radar imaging methods at a lower complexity. [C602]

"A new approach for height finding in 2-D search Radars"

In this paper, we present a new method for height finding in 2-D (range-azimuth) search radars. The idea is based on the fact that the rate at which Doppler frequency of a target changes as target moves away from or toward the radar, depends on the height of the target for fixed target range and velocity. Radon transform is used to find the rate of the Doppler frequency changes using Doppler history of the target over several scans. Analysis for calculation of target height from its range, Doppler frequency, the rate of Doppler changes and radar operating frequency is given in detail. A computer simulation is also accomplished to illustrate the performance of the proposed method. [C603]

"Directional moving target indication for civil traffic monitoring using single channel SAR"

This paper presents a novel moving target indicator which is selective with respect to a direction of interest. Preliminary results indicate that the obtained selectivity may have high interest in civil traffic monitoring using single channel SAR data. [C604]

"Analysis of bistatic tracking accuracy in passive radar"

In the paper, an analysis of bistatic tracking accuracy in passive radar is presented. The influence of parameters such as integration time, probability of false alarm, signal-to-noise ratio and spectral density of process noise is investigated. Simulations are performed for three popular types of illuminators of opportunity: FM, DAB and DVB-T. [C605]

"UWB radar-based human target tracking"

This paper presents a framework and algorithms for tracking the range of moving humans via a mono-static ultra-wideband (UWB) radar. The approach is based on a specular multi-path model for UWB radar scatters from walking humans. Empirical studies show that multipath time-of-arrival (TOA) can be modeled as a point process whose behavior is governed by a Gamma distribution. Based on this insight, we develop a tracking procedure that combines a Kalman Filter with a point process observation model whose measurements are processed with an Expectation-Maximization (EM) procedure. As a byproduct, the EM procedure solves the multi-target data segmentation and data association problems. We present experimental results in which a monostatic UWB radar tracks both individual and up to two human targets. [C606]

"Beam steering techniques for phased array multi-input-multi-output (MIMO) search radars"

When exploiting the output from multiple transmitters to enhance some aspect of radar performance, MIMO radars need to coordinate transmissions so that each transmitter illuminates the target. This paper analyzes the performance of standard beam steering techniques for search radars, and proposes a new technique that optimizes coverage out to the radar's instrumented range. [C607]

"An algorithm for UWB radar-based human detection"

This paper presents an algorithm for human presence detection in urban environments using an ultra-wide-band (UWB) impulse-based mono-static radar. A specular multi-path model (SMPM) is used to characterize human body scattered UWB waveforms. The SMPM parameters are used within a classical likelihood ratio detector framework to detect the presence of humans via gait, with the aid of a multi-target tracking technique (MTT). Experimental results on a simple human gait detection problem in an outdoor urban environment are presented to illustrate and validate the approach. [C608]

"Extending the frequency matching in linear FMCW radar exploiting extreme frequencies"

Frequency matching is an essential block of the signal processing chain in LFMCW (linear frequency modulated continuous wave) radar. Its task is to associate frequency detections obtained in multiple measurements. Under certain conditions, this association may fail and frequency detections from multiple real targets may be combined to a mismatch. The classification of a frequency association as match (real target) or mismatch (ghost target) is commonly regarded impossible if we only have frequency detections. Yet in this paper we show that even in this case, a reliable classification is possible when special attention is paid to the two outermost frequencies in each spectrum. Furthermore, the radar's modulation can be designed such that the reliable classification can be achieved in the regions of interest of the distance-velocity-plane, i.e. application-specific. [C609]

"Novel architecture for hardware efficient FPGA implementation of real time configurable "variable point FFT" using NIOS II™"

Signal processor forms the heart of the radar subsystems and is responsible for the discernment of targets from interfering clutter and improving the SNR of the received signal for better detection of targets. Doppler filter bank is one of the modules used in signal processor to extract the Doppler information from the target, to improve the SNR and it also provides information regarding target velocity. In this paper we present a novel and simple architecture to perform hardware efficient real time configurable ldquovariable point FFTrdquo using NIOSIItrade. The architecture can be used in multiple scan rate radars to reduce the resource utilization which can be used for other additional processing features. The architecture is generic in nature and can be extended to other platforms besides FPGA. [C610]

"An ISAR imaging method for multiple moving targets based on fractional Fourier transformation"

When multiple radar targets are close to each other, the returned signals from these targets are overlapped in time. The translational motion can be viewed as a uniformly accelerated motion, therefore, the Doppler variation of echoes in the cross-range direction can be approximated by the first-order polynomial which is called linear frequency modulation signal. For different targets, the chirp rates are different from each other. In this paper, a new algorithm based on fractional Fourier technique is proposed to separate the signals from different targets in each cross-range cell. By the CLEAN technique, the number of targets need not be specified. We derive original algorithms to compensate the motion of each target signal, so the image of each target can be obtained. The simulation results are given to demonstrate the efficiency of the proposed algorithm for multiple moving targets imaging. [C611]

"A tracking approach based on Dynamic Programming Track-Before-Detect"

Dynamic programming (DP) based track before detect (TBD) is an efficient algorithm to detect moving target with

slow maneuvers when the SNR is low. After the integration process of DP algorithm, however, the track separation phenomenon is a prevalent problem for trajectory recovering. In this paper, a modified DP algorithm is used to process the data after the envelope detection of radar system. The track separation phenomenon is analyzed and also a tracking approach is presented to minimize the track separation. Simulations are made to show the good performance of this tracking approach. [C612]

"Target detection in high clutter using passive bistatic WiFi radar"

The rapid rollout of wireless local area networks (WLANs) has provided a ubiquitous source of signal transmissions that may be exploited for surveillance applications using passive bistatic radar (PBR) and passive multistatic radar (PMR) systems. In this study, a series of experiments were conducted to examine the feasibility of using IEEE 802.11 wireless fidelity (WiFi) transmissions for detecting uncooperative targets in high clutter indoor environments. The range and Doppler characteristics of the system were also assessed theoretically from an ambiguity function analysis on WiFi signals having similar transmission parameters. Through-wall detections of personnel targets moving at differing velocities within an indoor environment are presented for the first time. The work demonstrates the feasibility for developing a low cost surveillance device that utilises WiFi networks as transmitters of opportunity. [C613]

"Rotating velocity estimation for ISAR targets via Radon detection of lines"

Rotating velocity (RV) estimation is a prerequisite for inverse synthetic aperture radar (ISAR) to re-scale the imaging results from the conventional range-Doppler (RD) domain to the range-cross range domain. Based on the mapping of RD imaging, two slope functions, i.e. Doppler-range slope and range-Doppler slope, are defined for a line on the image plane. Then, by detecting the line features on the RD plane with a radon-CLEAN scheme, this paper proposes a RV estimation method by fitting the slope function of the extracted line features. Key steps for the method are presented and numeric experiments are given to demonstrate the effectiveness of the proposed method. [C614]

"Fast Detection of Moving Targets by Focusing in UWB low frequency SAR"

Moving target detection in ultra-wideband (UWB) low frequency synthetic aperture radar (SAR) is associated with long integration time and has to handle azimuth focusing for reliable detection. This paper presents the theory and simulation results of the fast detection of moving targets by focusing method (FDMTF) which is understood as the detection of moving targets by focusing method (DMTF) incorporating fast time-domain algorithms in the process. Two fast time-domain algorithms fast backprojection (PBP) and fast factorized back-projection (FFBP) are considered. The results show that FDMTF performs very efficiently and still retains the ability of detection. [C615]

"GMTI MIMO radar"

Multiple-input multiple-output (MIMO) extensions to radar systems enable a number of advantages compared to traditional approaches. These advantages include improved angle estimation and target detection. In this paper, MIMO ground moving target indication (GMTI) radar is addressed. The concept of coherent MIMO radar is introduced. Comparisons are presented comparing MIMO GMTI and traditional radar performance. Simulations and theoretical bounds for MIMO GMTI angle estimation and minimum detectable velocity are presented. The simulations are evaluated in the time domain, enabling waveform design studies. For some applications, these results indicate significant potential improvements in clutter-mitigation SINR loss and reduction in angle-estimation error for slow-moving targets. [C616]

"Multistatic waveform design for seeing through the wall"

We present the matched illumination based waveform design for improved detection of targets behind walls and in enclosed structures using a multistatic radar system. The generalization of the matched illumination waveform design concept for through-the-wall multistatic operation bridges the problem to multiple-input multiple-output (MIMO) operation and puts in context the offering of MIMO to urban sensing and imaging of targets in enclosed structures. [C617]

"Weak Signal Detection Based on Chaotic Prediction"

In this paper, a weak signal detection method based on radial basis function (RBF) neural networks is discussed. The principle of weak signal detection with a background noise predictor is that the predictor trained by chaotic time series has a small prediction error, and the prediction error becomes relative large when the input contains a source or target. By exploiting the short-term predictability of the input signal, a one-step-ahead prediction

model is proposed as the basis of designing an RBF neural network. To enhance the detection performance in noisy background, the extended Kalman filter (EKF) is applied to perform the training and better parameter estimates can be acquired compared to the conventional RBF network training method. The performance of detection for low signal-to-noise ratio (SNR) is analyzed. Computer simulations show that the proposed method is effective for weak signal detection. [C618]

"Mitigation of radar range ambiguities via waveform diversity"

The USAF is considering a number of radar systems as a method to achieve persistent intelligence, surveillance and reconnaissance (ISR) over the Earth's surface. A comprehensive approach must be taken that identifies feasible radar system parameters, geometry, area coverage and processing approaches that will provide needed moving target indication MTI (both ground and air) performance. From the signal processing perspective, there are a number of unique technical challenges facing this concept. Issues which will need to be addressed include the restriction of antenna aperture and the need to locate and detect targets at shallow grazing angles These and other phenomenology will impact the ability of algorithms implemented by the system to perform image formation, target detection and parameter estimation. This paper presents a new approach to the problem of radar range ambiguities in synthetic aperture radar (SAR) imagery and surface moving target indication (SMTI). By using a combination a priori knowledge of the collection geometry, orthogonal waveforms and an alternative approach to traditional matched filter processing, it can be shown that the effects of the ambiguities can be mitigated and provide image quality and SMTI performance with little degradation as compared to the non-ambiguous case. [C619]

"MIMO Radar with Frequency Diversity"

We propose a new multiple-input, multiple-output (MIMO) radar system with colocated antennas that can greatly reduce target fluctuations. This is achieved by employing frequency diversity. The proposed MIMO radar system results in a radar array with frequency-division multiplexing that can also incorporate beamforming to design the transmission beam pattern. After presenting an overview of existing MIMO radar systems and their related signal models, we provide a detailed description of the proposed frequency diversity technique and the corresponding transmitter and receiver structures. Furthermore, we present a maximum likelihood estimation algorithm that incorporates frequency diversity with MIMO radar, derive the corresponding Cramer-Rao lower bound, and demonstrate its improved performance using numerical results. [C620]

"MIMO phased-array for SMTI radar"

Summary form only given. Waveform diversity techniques for radar have gained considerable interest over the past several years. Novel radar waveforms have been proposed to improve detection performance and metric accuracy (i.e., angle estimation performance). This paper explores the potential for using a waveform diversity technique known as Multiple Input, Multiple Output (MIMO) radar to improve the detection performance of slow moving surface targets from a moving radar platform. The MIMO radar system achieves superior performance by transmitting unique uncorrelated waveforms from each antenna subaperture as opposed to the traditional approach of transmitting a single coherent waveform across the entire aperture. The results show that the radar system minimum detectable velocity (MDV) can be reduced by exploiting the ability of a MIMO system to effectively increase the radar antenna aperture. [C621]

"Improved waveform design for target recognition with multiple transmissions"

This paper presents a matched waveform technique for target class identification, i.e., a multiple hypotheses testing (MHT) framework. This technique is shown to improve classification performance of SNR-based matched waveforms derived from a probability-weighted spectral variance (PWSV) approach. The technique, which allows for real-time adaptive waveform transmission, is also shown to be computationally efficient. [C622]

"Latency-Information Theory: A Novel Latency Theory Revealed as Time Dual of Information Theory"

This paper outlines a space-time duality study started in 2003 and leading to a latency-information theory (LIT) that unifies information theory with a novel latency theory revealed as time-dual. While information theory guides the design of communication systems, latency theory does the same for recognition systems. A unified recognition-communication system is an intelligence system and LIT illuminates its design. LIT naturally arose from the author's desire to systematically address the design of a real-world intelligence system for DARPA's knowledge-aided sensor signal processing expert reasoning (KASSPER) program. This work has led to practical intelligence system solutions that yield outstanding target detections under severely taxing environments, while also exhibiting several orders of magnitude savings in prior-knowledge storage-space, processing-time, and

implementation complexity over standard schemes. Moreover, it has led to the discovery of a mathematical-physical duality guiding life system designs. [C623]

"Sea Clutter Modeling Improvement and Target Detection by Tsallis Distribution"

Sea clutter is the backscattered returns from a patch of sea surface illuminated by a radar pulse and it's one of difficult domains in radar clutter modeling. A lot of efforts have been made to fit various distributions to the observed amplitude data of sea clutter. However, the fitting of those distributions to real sea clutter data is not good, and using parameters estimated from those distributions is not very effective for detecting targets within sea clutter. This may be due to the fact that sea clutter is highly non-stationary. Tsallis distribution is one of distributions that recommend in recent year for sea clutter modeling. This distribution is obtained by maximizing the Tsallis entropy. The Tsallis entropy is a generalization of the Shanon entropy. In this paper was found two weak points, by accomplished simulation analyses: a) By reason of using small step in parameters estimation, the time of modeling is long. b) By reason of using short segment of clutter data, decrease the target detection accuracy. By using the bigger step in this paper, increase the parameter estimation quickness and by using all sea clutter data and decrease performance, was improving the target detection accuracy. [C624]

"RCP-based HIL Simulation and Control for 2-DOF Tracking Robot of Maneuvering Target"

The research on tracking control system of maneuvering target is a hot issue. 2-DOF robot has kinematic capability of tracking non-maneuvering and maneuvering targets in air, while the servo control of the robot is crucial for the performance of target tracking. Traditional routine, including modeling, simulation and controller design, is a serial process, so the burdensome iterative steps bring about restrictions to the development period and efficiency. RCP as a live design can realize a smooth and fast transition from conceptual design to experimental verifications. Based on this technique a design routine is proposed and used for HIL simulation of 2-DOF tracking robot of maneuvering target. Experimental results show that the new routine is efficient and the requirements are better fulfilled. [C625]

"Classification of flowers by bats: comparison with the radar case"

In recent years, with the development of high range resolution radars, the desire to be able to identify targets under all weather and clutter conditions has become of great importance. This is an activity carried out with great success by echolocating mammals such as nectar feeding bats that are able to detect and select flowers of bat-pollinated plants even in a dense clutter environment. In this paper data consisting of acoustically generated high range resolution profiles of four bat pollinated flower heads are analysed. Multi perspective classification performance is assessed and compared with the radar case. There are close parallels that suggest lessons can be learnt from nature. [C626]

"Hardware Design of Signal Processing System Based on DSP"

Millimeter wave short range combined detection technology refers to that combining millimeter wave radar with radiometer and taking full advantage of the active range measurement and passive radiation characteristics of target to realize target bearing decision and target recognition, which is the development trend of millimeter wave detection technology and greatly improves the performances of millimeter wave detector. This paper takes TMS320VC5410 DSP chip as the core and utilizes the high-speed signal processing ability, rich on-chip resources and flexible external interfaces of C5410 DSP chip to finish the hardware design of signal processing system, including the following modules, such as AD sampling, memory extension, system power and system clock, etc, finally debugs the system and sums up the debugging experience. [C627]

"Monte-Carlo Based Estimation Methods for Rapidly-Varying Sea Clutter"

We consider two Monte-Carlo based methods for characterizing the scattering function of rapidly-varying sea clutter. The first method uses multiple particle filtering to estimate the clutter space-time covariance matrix by exploiting the structure of the matrix. This method is then compared to a baseline approach that estimates the clutter covariance matrix based on the Weibull distribution approximation. Both methods are evaluated by formulating a detection problem that simulates a small moving target in heavy sea clutter. [C628]

"Feature-aided global nearest pattern matching with non-Gaussian feature measurement errors"

System-level discrimination performance for missile defense relies on how well data can be associated between participating sensors. Under the existing architecture, there may be a handover of tracks between two sensors in which tracks formed by one sensor are passed to another sensor to improve knowledge of the targets. The global nearest pattern matching (GNPM) problem is a mathematical programming formulation that has proven to

be successful at correctly correlating tracks based solely on kinematic data from two sensors, while simultaneously removing inter-sensor bias and accounting for false tracks and missed detections. Despite this success, there is continued interest to improve correlation performance by exploiting feature data collected on targets. This paper addresses this issue by extending the GNPM formulation to account for feature observations whose measurement errors follow an arbitrary distribution. This is accomplished by augmenting the GNPM likelihood function to include a term representing the incremental likelihood of track-to-track assignments based solely on feature observations. Computational results are presented to illustrate the success of this approach. [C629]

"An adaptive compensation of moving target doppler shift for airborne radar"

Accurate estimation and compensation of the moving target Doppler shift are essential for the moving target detection of the airborne radar system. In this paper, an algorithm for the real-time estimation and compensation of the moving target Doppler shift due to the moving radar platform and target is presented for the airborne stepped frequency radar system. Under the condition of a small number of sample points, this new algorithm employs the twice compensation method in order to estimate and compensate the mean Doppler shift using high speed DSP based on Doppler FFT processing. Using simulated radar data, the moving target Doppler spectrum is measured and analyzed. The results of simulations show that this new algorithm can reduce the number of sample points and enhance the anti-interfering performance yet still obtain good Doppler estimation and compensation. [C630]

"Detection and diagnosis of radar modeling errors using covariance consistency"

Often, detection-based tracking algorithms are developed without much regard for the effects of either the radar's analog signal processing or its digital signal-processing algorithms. In this paper, we combine the effects of the radar's signal processing and tracking algorithms to assess the combined effect on covariance consistency of various algorithms. To do this, we first define the terms detection, detection primitive, and measurement. Next, we provide a detailed dataflow diagram for the processing chain of an electronically-scanned radar so that we can examine the propagation of truth data through various coordinate frames relative to radar signal processing. We examine issues related to expressing truth data in different frames and different relationships among targets. We describe in detail many of the algorithms in the signal-processing chain of typical monopulse radar and finally analyze and demonstrate the covariance consistency of various algorithms in the radar processing chain. When properly applied, covariance consistency analysis can be used to detect and correct inconsistent algorithms, invalid assumptions, and coding errors. The techniques described in this paper provide insight in determining system covariance requirements and may be used to ensure that both the design and implementation of radar processing algorithms provide good covariance consistency. The example simulations provide a baseline for algorithm covariance consistency, examine some common approximations used to simplify radar simulations, and demonstrate the effect of implementation errors that actually occurred during model development. [C631]

"Using complex-valued ICA to efficiently combine radar polarimetric data for target detection"

Target detection in sea clutter is a challenging problem in radar detection, specifically, when the Doppler return of the target and clutter are collocated. Polarization diverse radars provide additional information that enhances target detection. In this paper, we use an effective independent component analysis (ICA) approach, adaptive complex maximization of non-Gaussianity (A-CMN), to efficiently combine polarimetric radar data prior to detection. We show that A-CMN estimates the polarimetric scatter coefficients for the single target in clutter case, thereby providing matched-filter performance without the need for clutter or target models. The detection performance using ICA is evaluated with sea clutter collected with the McMaster IPIX radar off the coast of Canada. We also demonstrates the ability of this approach to adapt to the changing sea clutter conditions using simulation results. [C632]

"Image distance based ship detection using SAR images"

A novel method is developed for ship detection in synthetic aperture radar (SRA) images, which is based on image distance computation techniques. Using a second-order hidden Markov mesh model to learn statistical models of images, one can obtain the distance of two images for the purpose of detecting ships. First, the features of an image can be extracted using a method that best matches its statistical model, which is related to dynamic programming. Second, given the state transition matrix and observation distributions within states, statistical distance between images based on the similarity of their statistical models can be estimated. Experimental results demonstrate that this ship detection algorithm can effectively enhance ship target as well as suppress speckle and has better detection precision and lower calculation complexity. [C633]

"Reducing electromagnetic coupling for bistatic subsurface radar using EBG structures"

Bistatic radar is system which comprises a transmitter antenna and receiver antenna which are separated by a distance that is comparable to the expected target distance. In recent years, the bistatic subsurface radar is applied to detect relatively shallow structure such as tumor detection, steel reinforced detection in concrete and etc. On the other hand, the electromagnetic coupling between transmitter antenna and receiver antenna is problem, because, the bistatic radar detects a reflection wave from the target by the receiver antenna, therefore artifact caused by the coupling. To reduce this coupling a cavity is used, however, the cavity is not enough to reduce the electromagnetic coupling between transmitter antenna and receiver antenna. On the other hand, the EBG structure is used as electromagnetic insulator. In this research, in order to reduce the electromagnetic coupling the EBG structure is applied. [C634]

"Cognitive MIMO sonar based robust target detection for harbor and maritime surveillance applications"

Robust detection of various hostile threats is vital to protect Navy ships and other facilities within harbor and maritime environments. Traditional single-input single-output (SISO) sonar transmits single acoustic waveform by single projector, which has a few disadvantages including low target detection probability, low resolution, vulnerability of interception by the enemy, sensitivity to jamming, etc. Multi-input multi-output (MIMO), typically applied to communications and radar solutions, is an emerging technology that can be applied to sonar to overcome many of the SISO sonar disadvantages. In this paper, cognitive monostatic/bistatic/multistatic MIMO sonar approaches are proposed. MIMO sonar transmits different orthogonal acoustic waveforms from multiple projectors with different spatial distributions. Through space-time-waveform diversity, MIMO sonar is able to apply coherent processing techniques over the received signals, and acquires more diversity gains. The cognition concept proposed in the literature for radar and wireless communication is applied to MIMO sonar to improve its robustness and adaptability. The advantages of proposed cognitive MIMO sonar will be demonstrated by Monte Carlo computer simulations and compared to the SISO techniques. [C635]

"Adaptive OFDM radar for detecting a moving target in urban scenarios"

We address the problem of detecting a moving target in an urban canyon using an orthogonal frequency division multiplexing (OFDM) radar and exploiting the multipath reflections. The multipath propagation increases the spatial diversity of the radar system and provides different Doppler shifts over different path. In addition, the use of broadband OFDM signal provides frequency diversity to the system. We develop a parametric measurement model that accounts for the multipath components at multiple frequencies as well as Doppler shifts. Then, we develop a statistical detection test and evaluate its performance characteristics. Based on this, we propose an algorithm to optimally design the spectral weights for the next transmitting waveform. We present a few numerical examples to illustrate our analytical results. We demonstrate the achieved performance improvement due to the exploitation of multipath propagation, OFDM signalling, and adaptive waveform design. [C636]

"Adaptive waveform design in rapidly-varying radar scenes"

We consider a waveform-agile sensing algorithm for designing transmitted waveforms in rapidly-varying radar scenes to improve target detection performance. Specifically, we first track the scattering function of rapidly-varying sea clutter in low signal-to-clutter ratios (SCRs) at each burst by estimating the clutter's space-time covariance matrix. Simultaneously, we schedule the waveform to be transmitted in the next burst by minimizing the sea clutter influence based on the estimated clutter statistics. The effectiveness of our waveform-agile sensing approach is demonstrated by detecting a moving target in heavy sea clutter using configured waveforms, and then comparing the resulting performance to that of detecting the target using fixed-parameter linear frequency-modulated w.aveforms. [C637]

"Passive Coherent Location as Cognitive Radar"

Cognitive radar describes a generic radar system that is capable of adapting its transmission waveforms and cooperation with other sensors in order to achieve superior detection, recognition and tracking of targets. For example, the sensors of a cognitive radar system might use the illumination signals to carry broadcast data, allowing the sharing of target information. In this paper we postulate that it would be possible to implement a cognitive version of passive coherent location (PCL) which has much in common with the broad cognitive radar concept, but adapts only to the waveforms it senses in the environment, and exploits those that are most useful to it for target detection. In addition, it would model the terrain to improve coverage and provide countermeasures against direct signal saturation. By its name, PCL does not transmit, but relies on emissions from other radiating systems, such as broadcast services, other radars, cellular radio, WiFi, and so on. It is clear

that such a system, consisting of multiple, cooperating receivers, can achieve excellent performance in the presence of deliberate jamming, difficult terrain and attempts at target stealth. In the civilian radar domain, the technology offers opportunities for bandwidth conservation. [C638]

"Low-noise detector with RFI mitigation capability for the Aquarius L-band scatterometer"

The upcoming Aquarius sea-surface salinity mission has tight requirements on backscatter measurement accuracy and stability at L-band frequencies (1.26 GHz). These requirements have driven the development of new capabilities in the scatterometer's backend detector electronics, which are the focus of this paper. Topics include the development of flight-grade hardware aboard the scatterometer for radio frequency interference (RFI) detection and mitigation, and analog/digital electronics design techniques used to reduce system noise and achieve highly linear power detection over a wide dynamic range. We also summarize the approach taken to test the scatterometer's processing and control functions at the level of the integrated Aquarius flight instrument, and present some recent results from the integrated testing campaign. [C639]

"Advances in tactical laser radar"

Laser radar has enjoyed significant advances over the past decade. Novel sensor topologies, compact laser illuminators, and advanced signal processing have enabled the construction of low power, portable 2-D and 3-D laser vision systems. The applications of such systems range from surveillance, targeting, weapons guidance, and remote scene measurement, to target identification and atmospheric characterization. This paper serves to assemble some recent significant examples of laser radar in the context of emergent tactical applications. Strengths and limitations of competing topologies are also examined. [C640]

"Road traffic monitoring using a wireless vehicle sensor network"

With the advancement of micro-electro-mechanical systems (MEMS) technologies, wireless sensor networks have opened new vistas for a wide range of application domains. These sensor nodes usually comprise small, low-power devices that integrate sensors and actuators with limited on-board processing and wireless communication capabilities. One of the most important applications is target tracking and monitoring. Here a novel wireless vehicle monitoring system that is able to detect, classify and determine the direction of travel of vehicles on a two-lane road is proposed. Each vehicle detection node features multiple sensors including magnetometer, accelerometer, infrared and acoustic microphone with a two-node structure for cooperative monitoring. The results show that the system was capable of classifying the vehicle type (using vehicle weight) and their directional of travel with high accuracy. [C641]

"Multi-wavelength impacts on coastal radar performance during a sea breeze"

Sea breeze circulations dramatically impact the detection performance of coastal radar and are forecast to increase in strength and frequency into the 21stcentury. Dry and warm air from the land flows offshore between 100 and 200 meters above sea level out to 100 km offshore. This redistribution of water vapor and temperature creates strong vertical humidity and temperature gradients resulting in significant radar ducting. These thermodynamic gradients and resulting non-standard propagation structures vary in time and space as the sea breeze develops. Spatio-temporal radar skip zones develop within the ducts and reduced target detection ranges develop above the ducts. Notional S, C and X band radars are modeled with the advanced refractive effects prediction system and are located at the shoreline during a sea breeze. The azimuth and range dependent refractivity field is modeled by the regional atmospheric Mesoscale Prediction System. [C642]

"CA-CFAR detection in spatially correlated K-distributed sea clutter"

Radar detection of targets in sea clutter modelled by compound K-distribution is examined from a statistical detection viewpoint by Monte Carlo simulations. The detection performance of Cell Averaging Constant False Alarm Rate (CA-CFAR) is compared with the performance of fixed threshold detection. The performance evaluations are quantified by CFAR loss. Curves for CFAR loss to the spatial correlation and spikiness of sea clutter, number of cells of CA-CFAR processor and the number of non-coherently integrated pulses are presented. [C643]

"An optimal radar detector threshold adaptation for maneuvering targets in clutter"

In this paper, we consider the problem of radar detector threshold optimization for maneuvering targets in clutter. In the earlier works, the problem was studied in the context of the probabilistic data association filter (PDAF) for non-maneuvering targets. In this study, we have extended the ideas, which were applied to the PDAF, to the interacting multiple model PDAF (IMM-PDAF) for maneuvering targets. The proposed optimization problem and

its solution show better results over the traditional approaches in terms of track loss percentage and RMS position error criteria. [C644]

"Ship classification by sound signature"

Nowadays, either for supervision or for defense purposes, the transportation is being controlled by RADAR (Radio Detecting and Ranging). RADAR helps us get information about objects of interest by transmitting electromagnetic radio waves to the target and analyzing the reflecting signals. We understand that in order to determine any given object's information (speed, distance etc) the first action is always taken by the control center. This also tells us that the moving object can also notice the electromagnetic radio waves and hence the control center can also be sensed. It is of great importance in the defense systems that the object under inspection should not notice being recognized. If we could get information about the target by controlling the waves sent by the target rather than sending any signals to it we could be on the advantageous side. In this study the vehicles were classified by the sounds they make while operating. Working units of the marine vehicles (engine, fan, the generator and etc) analyzed and the sounds they diffuse to the environment while operating were characterized. In the characteristics determination the MFCC (Mel Frequency Cepstral Coefficients) method used to determine the features of the vehicles and by the k-means method, the defined features degraded to a specific number, k-NN (k-Nearest Neighbor) method selected for the classification and recognition of the vehicles. [C645]

"Most salient region tracking"

In this paper, we introduce a cognitive approach for object tracking from a mobile platform. The approach is based on a biologically motivated attention system which is able to detect regions of interest in images based on concepts of the human visual system. A top-down guided visual search module of the system enables to especially favor features which fit to a previously learned target object. Here, the appearance of an object is learned online within the first image in which it is detected. In subsequent images, the attention system searches for the target features and builds a top-down, target-related saliency map. This enables to focus on the most relevant features of especially this object in especially this scene without knowing anything about a particular object model or scene in advance. The system is able to operate in real-time and to cope with the requirements of real-world tasks such as illumination variations and other moving objects. [C646]

"Time-scale analysis of wideband HFM signal and application on moving target detection"

The interchangeability between time scale and time shift of wideband HFM signal is proposed. The self-CWT ridge of the rectangle enveloped HFM signal is derived in detail. Moving target detection and signal design are discussed. The numerical simulation is done to verify the characteristic of the ridge. Also the analysis and simulation of the LFM signal is given as a contrast. Real time simulation results are presented and show the prospect of wideband HFM signals in underwater signal processing applications. [C647]

"Research on target DOA estimation method using MIMO sonar"

In this paper, a new space-time coding configuration for target direction finding by active arrays called multi-input multi-output (MIMO) arrays is proposed. Multiple mutually uncorrelated (orthogonal) probing signals are transmitted by MIMO array whose steering vectors are the convolution of transmit and receive steering vectors of conventional phased array, which is essentially equivalent to extending the array aperture by additional virtual sensors. These virtual sensors can be used to form narrower beams with lower sidelobes because MIMO array beam pattern is the product of the transmit beam pattern and the receive beam pattern. Minimum variance distortionless response (MVDR) method for DOA is studied and simulations and experiments show that the MIMO array can achieve better performance in target detection and angular resolution over conventional phased arrays. [C648]

"Hardware Design of Signal Processing System Based on DSP"

Millimeter wave short range combined detection technology refers to that combining millimeter wave radar with radiometer and taking full advantage of the active range measurement and passive radiation characteristics of target to realize target bearing decision and target recognition, which is the development trend of millimeter wave detection technology and greatly improves the performances of millimeter wave detector. This paper takes TMS320VC5410 DSP chip as the core and utilizes the high-speed signal processing ability, rich on-chip resources and flexible external interfaces of C5410 DSP chip to finish the hardware design of signal processing system, including the following modules, such as AD sampling, memory extension, system power and system clock, etc, finally debugs the system and sums up the debugging experience. [C649]

"2D imaging of shallow buried objects based on frequency domain data"

A new buried object detection algorithm using ground penetrating radar system based on the UWB frequency domain measurements is proposed. With the implementation of C-scan data acquisition and wide angle reflection and refraction schemes, the 2D imaging of metallic and plastic mine-like targets buried in dry soil is demonstrated. [C650]

"Design of tapered-slot antenna arrays for landmine detection"

Two compact ultra-wideband antenna arrays built of tapered-slot antennas and intended for landmine surveys are described. In one array, the antennas are arranged in two parallel lines differing by the antenna polarizations. Polarimetric data collected by the array are important for the detection of lengthy objects buried in the ground. The antennas in the second array form a zigzag line with reduced spacing between adjacent transmitting/receiving antenna pairs. Such a dense array is useful to detect small buried targets like landmines. Some experimental examples for the both arrays are presented. [C651]

"Vision enhancement system for SAR based on infrared video"

With the expansion of the transportation volume at sea, maritime search and rescue became an enormous task. To improve the rate of life saving, this paper puts forward a vision enhancement system based on infrared video for the maritime search and rescue. A method is proposed for detecting and tracking targets at sea. Based on the characteristics of infrared image and the sea environment, we combine the approaches of frame difference and target region-growth to detect and track targets. The image of the current frame is different from the previous one and the result is transformed into a binary image using threshold segmentation. Then the region growth algorithm is employed to mark the targets' position on the video. The experimental result shows that the system is suitable for searching the overboard personnel at sea. [C652]

"UWB Radar for Railway Fall on Track Object Detection and Identification"

This paper presents a new system for detecting and identifying objects fallen onto railway tracks. The proposed solution is based on an ultra-wideband (UWB) radar technique combined with a long travelling wave radiating microwave transmission line. This line is maintained adequately all along the railway station platform. Scheduled steps for system realization are presented. A preliminary analysis of different transmission lines which could be used and their performance is provided. Automatic Target Recognition (ATR) application, which describes identification procedure, is discussed. An overview of extraction methods is provided and a procedure of selection of contributing poles is presented. Available target identification techniques based on UWB pulse are analyzed and compared to experimental results. [C653]

"A Method of Same Frequency Interference Elimination Based on Adaptive Notch Filter"

The torpedo active electromagnetic fuze is an active electromagnetic detection system, as the distance between the transmitting and receiving antennas is very short, the direct coupling signal will inevitably appear in the receiving signals. This interference has the same frequency as target signal, and is of great harm to the detection system's normal operation. Traditional methods of same frequency interference elimination were analyzed, and it was found that neither of them were suitable for the object studied in this paper, so a method of same frequency interference elimination was put forward based on adaptive notch filter. Its working principle, working process and performance were analyzed; also its numerical value simulation and engineering test had been carried out. The results indicated that as long as the magnitude and phase of the same frequency remained unchanged, it would be effectively eliminated with this method; moreover, this method could be used in a low SNR situation. [C654]

"An efficient approach to compute the RCS of complex targets considering multiple bounces"

An approach for computing efficiently monostatic and/or bistatic radar cross section (RCS) of complex targets considering multiple bounces is presented. The approach is based on physical optics (PO), the equivalent currents method (ECM), geometrical optics (GO) and a new ray-tracing accelerating algorithm. The new tool is very efficient and save memory and resources computing the RCS considering different iterations. Monostatic or bistatic RCS of complex targets modelled by planar or parametric surfaces can be obtained. The program has its own facility to generate or modify an existing geometry. [C655]

"ADS-B based collision avoidance radar for unmanned aerial vehicles"

This paper describes an ADS-B based collision avoidance radar that allows small autonomous UAVs to detect

cooperative and non-cooperative targets in air space co-located with manned air. The targeted host platforms are small UAVs with 3.3 m or shorter wing spans. This radar system is effective against all air traffic, with or without transponder-based collision avoidance systems such as TCAS or ADS-B. It is even effective for stationary structures such as high-rise buildings and towers. It is based on the standard ADS-B signal, so no additional spectrum is needed. This system can leverage many commercial off-the-shelf components in existing transponders. Furthermore, it does not require modifications to the existing air traffic control system in the Continental United States or worldwide. Therefore, it should be easier to get the FAA's approval. The development and manufacturing costs are relatively inexpensive. [C656]

"Probability estimation for an automotive Pre-Crash application with short filter settling times"

In this paper, the merits of incorporating covariance propagation into a real-time Pre-Crash application are investigated. The suggested Pre-Crash algorithm activates restraint systems, such as a reversible seat belt tightening system, before an unavoidable accident happens. Sensor fusion of two short-range and one long-range radar with a target-based fusion is used to realize this vehicle safety application. A powerful, yet applicable method for using not only state but also covariance information for triggering actuators is proposed. A comprehensive parameter study on simulated as well as on real data shows statistically significant improvements in detection rate. Further, the importance of covariance errors in terms of accuracy for Pre-Crash applications is demonstrated. Even with few detection cycles and short filter settling times, a good compromise between detection rate and false alarms can be deduced. [C657]

"Ego-motion estimation and moving object tracking using multi-layer LIDAR"

This paper presents an approach for the robust recognition of a complex and dynamic driving environment, such as an urban area, using on-vehicle multilayer LIDAR. The multilayer LIDAR alleviates the consequences of occlusion by vertical scanning; it can detect objects with different heights simultaneously, and therefore the influence of occlusion can be curbed. The road environment recognition algorithm proposed in this paper consists of three procedures: ego-motion estimation, construction and updating of a 3-dimensional local grid map, and the detection and tracking of moving objects. The integration of these procedures enables us to estimate ego-motion accurately, along with the positions and states of moving objects, the free area where vehicles and pedestrians can move freely, and the dasiaunknownpsila area, which have never previously been observed in a road environment. [C658]

"The low probability of intercept radar systems with spatial feedback"

The radar system with spatial positive feedback throw the target is considered. In this system there are self-oscillations, if the system is closed through a space of the signal radio-path and the target. When the target is absent (system is not closed), transmitter output power of the noise signal is insignificant, and that complicates detection of the radar radiation. In the report principles of such system functioning and results of tests on the real targets are statedrdquo. [C659]

"Jamming detection in providing for radar jamming immunity"

The article considers the objective of providing for radar jamming immunity by optimizing the radar structure, parameters or operating algorithms on the basis of correct recognition of jamming in progress. Procedure of recognition in the determined feature space is examined. Viability of this approach is demonstrated using the example of airborne radar operation against the source of polarization and blinking jamming. [C660]

"Title Page i"

The following topics are dealt with: signal processing system; speech recognition; hidden Markov model; TDOA; DSP; Radon transform; iris recognition; wireless sensor network; watermarking; image registration; radar detection; genetic algorithm; routing protocol; OFDM; wireless channel; steganography; FPGA; adaptive filter; FIR filter; video surveillance; target tracking; data mining; image processing; rough set theory; TCP; fuzzy inference rule; RBF neural network; MIMO system; case-based reasoning; encryption; P2P network and image compression. [C661]

"Analysis of some CFAR detectors in nonhomogenous environments based on switching algorithm"

In radar signal processing distinction of false targets from real targets and fixing their rate in different radar environments is desirable. In this paper, at first, switching constant false alarm rate (S-CFAR) processor has been improved to achieve Improved SCFAR in order to fix the false alarm rate not only in homogenous environment only with thermal noise but also in non-homogenous environment, consisting clutter edge and

multiple targets in the background Gaussian noise. Then in continue, a new CFAR detector which is composed of an excisior and a switching CFAR detector, in an environment with K distribution, has been introduced. The new detector is named an excision switching CFAR (EXS-CFAR). The equations have been achieved by assuming the targets in Swerling I and closed form. The simulation results confirm that the introduced processors can fix the false alarm rate in both homogenous and non-homogenous environment with less detection loss. In addition, this method is simpler in implementation comparing with other samples ordering processors. [C662]

"A novel interacting multiple model algorithm based on multi-sensor optimal information fusion rule"

In this paper, a novel interacting multiple model (IMM) algorithm is proposed, which utilizes a multi-sensor optimal information fusion rule to combine multiple models in the linear minimum variance sense instead of famous Bayes' rule. Furthermore, the diagonal matrices are used as the updated weights of models, which are applied to distinguish the effects produced by different dimensions of state, so the new algorithm is named as diagonal interacting multiple model (DIMM) algorithm. Extensive Monte Carlo simulations indicate that the proposed DIMM algorithm has better accuracy of estimation than the IMM algorithm with no increase in the execution time, which confirm that the DIMM algorithm is a competitive alternative to the classical IMM algorithm. [C663]

"Modeling the effective target cross section in optical band"

In this paper a method for calculation of the target cross section in the optical band is presented. Local parameters of the target for determination of the total cross section are used. The power balance equation of the optical radar system, influence of the turbulent flow and atmosphere attenuation in Matlab utility are calculated. [C664]

"A GPS-based system design for the recognition and tracking of moving targets"

This study aimed to develop a software to enable recognition of moving objects and detection of their orbits by processing the images obtained through a camera. The secondary objective was to design a GPS-based mobile robot which tracks moving objects. [C665]

"Multiresolution Framwork with Neural Network Approach for Automatic Target Recognition (ATR)"

Automatic Target Recognition (ATR) is an approach by which we identify one or a group of target-objects in a scene. It plays a pivotal role in the challenging fields of defense and civil. Most of the methods in this context are based on fix window-size technique. In this paper we propose a novel approach which gives scale, rotation and translation invariant results for automatic target recognition in high-resolution satellite images which in turn are able to recognize the multiple targets in a scene. We have developed a system which can predict the possible area of interest in a scene, where target may be present or not. Prediction of areas of interest is based on edge detection and similarity measure of wavelet co-occurrence features of segmented sub-blocks. Zernike moments, calculated for scale and translation normalized area of interest, is thereby used as the features of the concerned area. Zernike moments are rotation invariant. The extracted features are then fed to trained neural network for recognition. This approach is more suitable for the satellite images because resolution of image and idea about the target are two essential factors by which we can predict the minimum and maximum size of the target. The approach takes considerably less time compared to the fix window based approach because the predicted numbers of interest areas to be processed in a scene are very less. The proposed approach has successfully been tested on number of satellite images of different resolutions and their timing analysis has been compared with fix window based approach. [C666]

"Research on Characteristic Extraction of Human Gait"

When a human walks, the motion of various components of the body including the head, torso, arms, legs, and feet produce a very characteristic Doppler signature. A new signal model of the walking human, based on the linear frequency modulated (LFM) signal, is proposed. This model contains 12 scatter-points of human, together with kinematic equations of motion of each body part. For each part of human body, an estimated radar cross section was assigned by the radar range equation. Short time Fourier transform (STFT) is used to obtain the human's spectrogram at first, from which the walking velocity can be estimated. Both a traditional method based on the cadence frequency and a new echo decomposition method are used to obtain the human gait frequency. Several unique features of human targets, like the height of human and so on, can be revealed by utilizing these parameters. Some simulations show that basic information extraction from spectrogram has some ability to identification human targets. [C667]

"Remote Sensing of Human Body by Stepped-Frequency Continuous-Wave"

Remote sensing of human body is very useful in many services. The micro-Doppler characteristic of human body can be detected to identify life target. In this paper, another new theoretical method to obtain the range and Doppler frequency of human body is proposed in which multiple periods stepped- frequency continuous-wave signal and moving target indication (MTI) filter are adopted. The simulation results illustrate the validity of this method and present the detection of the target range and the vibration frequency of heart beating and breathing. [C668]

"Performance deterioration of the matched filter detector in partially correlated texture based compound-Gaussian clutter environment"

This paper addresses the problem of radar target detection in the presence of non-Gaussian clutter modeled in compound-Gaussian form which realizes the clutter process as a product of two independent random processes can be called as ldquotexturerdquo and ldquospecklerdquo. The existing matched filter (MF) detectors suit and are applicable to radar target detection in the presence of compound-Gaussian clutter. However, in view of scanning while detecting in a radar the textural component of the compound-Gaussian clutter exhibits a correlation which is less than unity. Therefore, it was needed to model the clutter in compound-Gaussian form considering partial correlation of texture and clutter modulation which arises as a result of antenna scanning. MF based detectors existing in the literature is expected to yield a fall in the detection performance in such clutter environment. Here in this paper, the performance of the existing MF detector is studied in detail for partially correlated texture scenario. Furthermore performance of the detector is mathematically analyzed to show its relationship with the texture correlation value. Analytical and simulation results show that for partially correlated texture the existing MF detector performance degrades significantly as compared to the completely correlated texture case. [C669]

"Development and integration of the aquarius scatterometer processor/control electronics for achieving high measurement accuracy"

The upcoming Aquarius sea-surface salinity mission has tight requirements on backscatter measurement accuracy and stability at L-band frequencies (1.26 GHz). These requirements have driven the development of new capabilities in the radar's backend detector electronics, which are the focus of this paper. Topics include the development of flight-grade hardware aboard the scatterometer for radio frequency interference (RFI) detection and mitigation, and analog/digital electronics design techniques that reduce system noise and yield highly linear power detection over a wide dynamic range. We also summarize the approach taken to test the scatterometer's processing and control functions at the level of the integrated Aquarius flight instrument, and present some recent results from the integrated testing campaign. [C670]

"Clutter modeling for bistatic SAR with phased array antenna and arbitrary geometry configuration"

For bistatic synthetic aperture radar (Bi-SAR) with phased array antenna and arbitrary bi-static geometry configuration, this paper proposes a clutter modeling method for clutter suppressing and ground moving target detection. Furthermore, based on the simulated space-time clutter spectrum of four typical specific geometry configurations, the detailed analysis is also given for the clutter suppressing performance with space-time adaptive processing (STAP), Finally, some important conclusions are given for Bi-SAR with different geometry configuration. [C671]

"Synthetic Aperture Radar moving target indication processing of along-track monopulse nonlinear gotcha data"

This paper is concerned with imaging and moving target detection using a synthetic aperture radar (SAR) platform that is known as Gotcha. The SAR platform can interrogate a scene using an imperfect circular trajectory; we refer to this as nonlinear SAR data collection. This collection can make monostatic and quasi-monostatic measurements in the along-track domain. We present subaperture-based wavefront reconstruction algorithms for motion compensation and imaging from this nonlinear SAR database. We also discuss adaptive filtering algorithms to construct MTI imagery from the two receiver channels of the system. Results will be provided. [C672]

"Multistatic Pulse-Wave Angle-of-arrival-assisted relative interferometric RADAR"

In this work we propose a Pulse-Wave (PW) extension to the Angle-of-arrival-assisted Radio Interferometry (ARI) technique to dramatically reduce the scan-time and the number of vantage points necessary to obtain high-fidelity target position estimation. Accordingly, we call this enhanced process PW-ARI. PW-ARI is the fusion

of data from three domains: time (time-of-flight), phase (relative phase-of-arrival), and angle (direction-of-arrival). It has a number of desirable attributes. Foremost among these are its ability to rapidly image extremely large volumes with high accuracy and dense target clusters, support an infinite number of friendly aircraft while providing stealth operational support, and present a spectrally small footprint to both hostile (evade detection and counter-measures) and friendly (maximize electromagnetic compatibility) systems. [C673]

"A novel W-MUSIC algorithm for GPR target detection in noisy and distorted signals"

When applied to ground penetrating radar (GPR), the multiple signal classification (MUSIC) algorithm is an important frequency estimation method as it can detect very closely spaced targets, particularly when one of the target responses is substantially less than another. The MUSIC algorithm however must be seeded with the number of targets to find and will indicate that number of targets regardless of the number of targets actually present. In addition, there is no reliable indication of the magnitude of the responses of the targets. In the presence of relatively low levels of noise the MUSIC algorithm is prone to reporting the position of false target positions in preference to weaker genuine target responses. In this paper a superimposed MUSIC technique is proposed to suppress false targets. A novel windowed FFT MUSIC (W-MUSIC) algorithm is examined using a linear sweep frequency in noise, and it is seen to give a clear indication of targets. In the presence of distortion, FFT is seen to be a more robust approach than the MUSIC algorithm, the latter method becoming very prone to inaccuracy in the presence of distortion. [C674]

"An approach to ground moving target indication (GMTI) using multiple resolutions of the clutter covariance matrix"

This paper presents an approach to simultaneous ground moving target indication (GMTI) and synthetic aperture radar (SAR) imaging that promises to outperform current space-time adaptive processing (STAP) GMTI techniques when jamming is not present. An inherent weakness in STAP is its inability to directly estimate the scattering statistics from nonmoving objects in the region under test. A SAR image is a measure of the scattering intensity from an illuminated area on Earth assuming everything in the scene is stationary; therefore, it provides the estimate of scattering from nonmoving targets required for GMTI. Since the homogeneity of the scattering statistics over the scene are unknown, using multiple spatial resolutions of the SAR image to estimate the scattering statistics results in more confidence in the final detection decision. [C675]

"Gain-constrained adaptive pulse compression via an MVDR framework"

Much work has been done to discover pulse compression methods that alleviate the effects of range sidelobes, though pulse compression filters that deviate from the matched filter suffer from varying degrees of mismatch loss. The Minimum Mean-Square Error (MMSE) based Adaptive Pulse Compression (APC) algorithm is capable of suppressing range sidelobes into the noise by employing a unique pulse compression filter for each range cell. Recently, Fast APC (FAPC) has been developed to reduce the computational cost of APC while maintaining much of the sidelobe suppression capability. This paper utilizes the MVDR framework to facilitate inclusion of a unity gain constraint within the APC and FAPC cost functions in an effort to mitigate mismatch loss. The APC algorithm exhibits almost no mismatch loss and, as such, the full-dimension algorithm benefits little from the gain constraint. However, FAPC occasionally suppresses small targets in dense scattering environments due to fewer degrees of freedom inherent to reduced-dimensionality processing. The constrained FAPC algorithm preserves gain on small targets consequently improving detection performance. [C676]

"Digital beamforming of multiple simultaneous beams for improved target search"

This paper describes several digital beamforming radar techniques for improving target detection and determination of the angular location of a target using multiple simultaneous received beams. These techniques improve target search and angle estimation performance over the conventional monopulse processing in the elimination of beam-shape loss. [C677]

"A coherent Radon transform for small target detection"

The Radon transform can be used to implement grid based ldquotrack-before-detectrdquo processors. The approach can be described as a range alignment step followed by non-coherent integration. In this paper, a modification of the conventional direct Radon transform is proposed to coherently integrate the energy of the target. In this way, the noise and clutter contributions to each projection angle can be minimized and the overall performance of the system will improve. [C678]

"Improving the radar detection ange of low flying aircraft in clutter with ultra-widband short pulses

and active side lobe reduction"

This paper proposes a method for airborne fire control radars in their air-to-air modes to improve the radar detection range of targets intentionally flying to present Doppler returns that fall either into main lobe clutter or altitude return. The use of UWB short pulses improves the target to clutter ratio and hence the radar detection range. [C679]

"The CP140 Imaging Radar System AN/APS-508: Architecture and early flight test results"

The CP140 Imaging Radar System (IRS) is a multi-mode radar under development for the Canadian DND to fly on the CP140 Aurora fleet. Denoted the AN/APS-508, the IRS provides several surveillance and imaging modes for blue water, littoral and overland missions. The system architecture includes a number of features to support this broad range of functionality, including two back-to-back antennas, one incorporating three phase centres for Ground Moving Target Indicator (GMTI), active dynamic range management and calibration for all imaging modes and GMTI. Installed on a Convair CV580, the system completed preliminary flight trial testing in Central and Eastern Canada during 2008, with all modes successfully demonstrated. [C680]

"Performance of random OFDM radar signals in deception jamming scenarios"

The paper examines the performance of randomly generated OFDM waveforms in presence of deception jamming. The scenario of interest uses OFDM waveforms for synthetic aperture radar (SAR) imaging of a target area into which a digital radio frequency memory (DRFM) repeat jammer has been introduced. The jammer attempts to introduce false targets into the final image by replicating the radar transmitted waveform. SAR images are often constructed using a back projection algorithm requiring the presence of a false target to rely heavily on the matched filter (MF) output of the radar and jamming signals. Monte Carlo simulations are performed to determine probability density functions for maximum MF output for both cross-correlation and auto-correlation of the random OFDM waveforms containing WGN. A MF threshold is then chosen and probability of false alarm and probability of detection are simulated for varying SNRs. [C681]

"Parameter estimation based coherent multistatic processing"

This paper develops the coherent generalized likelihood ratio test (GLRT) and the MVDR statistic for multistatic radar systems, conditioned on estimation of certain parameters that render the system coherent. Analytical and computer simulation results are presented to show substantially enhanced detection and geolocation of moving targets in clutter. [C682]

"Waveform design for distributed aperture in through-the-wall radar"

Distributed aperture allows the implementation of matched illumination waveform design for improved target detection in through-the-wall radar imaging and sensing applications. We consider a multistatic radar system for detection of stationary targets with known impulse responses behind walls. The stationary and slowly moving nature of typical indoor targets relaxes the orthogonality requirement on the waveforms, thereby allowing sequential transmissions from each transmitter with simultaneous reception at multiple receivers. Performance of the matched illumination multistatic waveforms is evaluated under range gate and target orientation errors using electromagnetic modeling data. [C683]

"Ku-band retrodirective radar for ballistic projectile detection and tracking"

A Ku-band radar has been developed for detection and tracking of sniper rifle bullets and other ballistic projectiles. The radar utilizes a novel retrodirective architecture based on separate 8-element receive and transmit antenna arrays. A pseudorandom noise waveform provides for precise ranging and high processing gain. Digital filtering allows for discrimination of high-velocity bullets and small supersonic projectiles up to at least 1700 ft/s, as demonstrated experimentally in field tests. [C684]

"The use of wavelet transformation for detection and recognition of the small size and small contrast subsurface targets"

In this paper, possibilities of use of the wavelet analysis for detection and recognition of small size and small contrast subsurface targets are considered. For the test image the wavelet spectrum was performed and its analysis was carried out. [C685]

"A brief history of waveform diversity"

The U.S. Air Force has set an ambitious goal to be able to anticipate, find, fix, track, target, engage, and assess-

anything, anytime, anywhere. We will not achieve order of magnitude improvement in detection and tracking performance solely through larger antennas and more power. Instead, advanced signal processing techniques and system concepts will be required. Achieving the sought after demanding goals will instead require a distributed network of heterogeneous sensors. [C686]

"Enhanced multistatic radar resolution via STC"

MIMO radar can improve on conventional target detection, parameter identification, and target classification performance via diversity of, among other things, its simultaneously-transmitted waveforms. However, the mutual interference among the waveforms may lead to considerable performance degradation suppressing clutter near targets. In this paper, we consider the use of space time coding (STC) to mitigate waveform cross-correlation effects in MIMO radar. First, it turns out that a joint waveform optimization problem can be decoupled into a set of individual waveform design problems. Second, a number of monostatic waveforms can be directly used in a MIMO radar system, which offers flexibility in waveform selection. Numerical results demonstrate the effectiveness of STC in MIMO radar for waveform decorrelation. [C687]

"A multifrequency interferometric CW radar for vital signs detection"

The use of radar techniques to detect minute body movements which are associated with respiration and cardiac activity (vital signs) is known at least since 1975 when J.C. Linn and J. Salinger proposed a non-contact microwave respiration monitor. This paper sets up to discuss further development of CW radar based vital signs detection systems. The purpose here is to enhance target detection probability in a highly cluttered environment and to add range and angle-of-arrival estimation without dramatically enhancing RF spectrum requirements by transition to a multicarrier interrogating signal. [C688]

"Fractal-based variable step-size least mean square algorithm for radar target detection in sea clutter"

This paper introduces fractal-based variable step-size least mean square(FB-VSLMS) algorithm and proposes a model for radar target detection in sea clutter. FB-VSLMS algorithm deals with a specific class of fractal signals and except one of the step-size parameters requiring time-varying constraints, the constraints on the remaining parameters are time-invariant. And the step-size matrix is determined completely with the knowledge of the deterministic Hurst exponent. The model based on this algorithm is suited for tracking signals from the family of fractal signals that are inherently nonstationary. In the end, the performance of the novel model is analyzed. By the verification of X-band real sea clutter, the model is shown to be effective for point target detection in sea clutter. [C689]

"Time-frequency entropy of Hilbert-Huang transformation for detecting weak target in sea clutter"

In this paper, Hilbert-Huang transformation is adopted for analyzing the sea clutter with the fixed weak target. It's found that the fixed target only affects the low frequency component of the sea clutter. So the time-frequency entropy of the low frequency component is applied for the weak target detection. Compared with another weak target detection method directly using the box dimension, the method proposed in this paper improves the effect of the fixed target on the sea clutter. And the detection performance of the fixed weak target is improved distinctly. [C690]

"Multistatic scattering from moving targets in multipath environments"

We are examining the feasibility of ground target detection and tracking in urban centers using ground moving target indicator (GMTI) radar when line-of-sight (LOS) coverage is intermittent, yet multipath responses from building walls are available. We enhance the standard ray-tracing propagation methods that assume specular wall reflections and point scattering target models. Our two-dimensional analysis includes near field reradiation from the illuminated wall to a target having a multistatic response. We also evaluate the degradation of power and coherency in the signal processing due to wall surface roughness. Results of this work provide insight for the development of processing techniques that may be required for multipath exploitation radar. [C691]

"Using shaped phase-thresholds for detecting moving targets in multiple-channel SAR"

The authors have developed a technique for detecting moving surface targets in a single frame of short-duration multi-channel SAR image using phase interferometry. For a pixel to be associated with a moving target, we require it to exceed both a magnitude threshold in the SAR image and a phase threshold in the corresponding interferometric phase image. Here we show that a magnitude-dependent interferometric phase threshold, i.e., a shaped phase threshold, is a better choice than a constant phase threshold. In addition, we show that the

interferometric phase reference plane needed for checking deviations, when computed from the geometry alone, provides superior detection performance over an interferometric phase plane estimated from the data. In this paper, we present results using airborne SAR data. [C692]

"On the optimality of detectors defined over the ambiguity plane"

We study the detectors based on the ambiguity function. These detectors have been shown to be useful for the detection of linear frequency modulated (LFM) signals in the literature. We show that the detectors based on the projection of the cross-ambiguity surface are optimal for the detection of non-fluctuating targets in the Bayesian sense. The given optimality property strengthens the earlier results in the literature and enables us to compare different classes of detectors. [C693]

"Detecting weak targets in a speckled distributed scene by SAR reconfiguration"

In this paper a discussion on the difference between point-like targets and distributed scene in SAR images is presented starting from basic radar equations. The target detection requirements are formulated considering also the speckle characteristics of the distributed scattering of the background. An equation is presented for the estimation of the minimum radar cross section of a target to become detectable within a scene with speckled distributed background and detection criteria are discussed for the multi-look case. Experimental evaluations are based on airborne SAR data of a calibration test site. [C694]

"3D SAR focusing for subsurface point targets"

In this work we develop a methodology for imaging subsurface point targets using a single-pass strip-map synthetic aperture radar (SAR). The point targets are embedded in an arbitrary homogeneous half space, and are located at arbitrary depths. It is assumed that the radar frequency is low enough and system sensitivity high enough to allow the required two-way penetration depth to target. The succession of steps required to form the image of the subsurface point targets are described, including the estimation of the subsurface wave velocity, estimation of the depth of the point target, and the modified range and azimuth filters to achieve optimum resolution. The theoretical approach is described and results are presented for a range of point target depths, subsurface velocities, and radar system parameters. It is found that with the assumptions made it is possible to image the point targets in 3D with good range, azimuth, and depth accuracy. [C695]

"High range resolution directional borehole radar for 3-D fracture delineation"

Directional borehole radar was developed for detection of three-dimensional (3-D) target localization in single-hole radar measurement. Phase differences among four dipole elements of receiving circular array uniquely determine an azimuth direction of a reflected wave. Receiving voltages of dipole elements are measured by optical electric field sensors whose high electrical isolation feature enables data acquisition of highly correlated signal between the channels. Besides, a switching unit to control resonant frequency of dipole elements was newly developed to reduce mutual coupling between the dipole elements. Laboratory experiments have demonstrated that approximately 30% frequency bandwidth enlargement is achieved by the switching operation without been affected by the mutual coupling in air. The directional borehole radar system was tested in a field test site in Kamaishi-Mine in Japan. All the boreholes available in this test site is filled with water and past borehole radar surveys conducted in this test site revealed presence of complex fracture system. Cross-hole and single-hole borehole radar measurement were conducted to clarify the performance of the resonant switching control and also to detect 3-D geometrical structure of fractures in this test site. 3-D analysis of data acquired by the directional borehole radar in a single-hole measurement clarified azimuth orientation fractures up to a range distance of 15 m with a range resolution less than 1 m. High reliability of the result was inferred from the fact that individual fracture pattern in a reflection profile showed a consistent color along the depth and also high repeatability of the result was obtained by repeating measurements. [C696]

"Control of unmanned aerial vehicles performing multiple target passive detection and tracking"

Advances in a previously proposed algorithm for trajectory optimization of autonomous aerial vehicles performing multiple target tracking are presented. The algorithm involves a variant of the moving horizon control approach, built on a partially observed Markov decision process (POMDP) model of the sensor-target system. To evaluate the effectiveness of the advances a simulation involving multiple UAVs and targets is performed. [C697]

"Kernel regression-based background predicting method for target detection in SAR image"

Target detection with SAR image is one of important research topics in remote sensing. In this paper, a kernel regression-based predicting method is proposed for target detection in SAR image. Badly speckle noise and

background clutter are two main factors which make the target detection with SAR image difficult. In the proposed method, the kernel regression on local image is used to exactly predict the background interferences and make Gaussian assumption in conventional detector better followed after kernel regression-based prediction and suppression of background clutter. Thus, final CFAR detection is performed on the background clutter-removed SAR image. Experiments conducted on real SAR image show that the proposed algorithm can effectively predict and suppress background clutters, and greatly improve the performance of the conventional CFAR detector. [C698]

"A preliminary study of target contour extraction based on scattering mechanism using polarimetric SAR images"

Finding the target contour information from a remote sensing image is one of the fundamental steps for image analysis. Conventional target contour extraction methods are usually based on the statistics information of the image. In this paper, using the maximum return value of the normalized scattering matrix derived from full-polarized Synthetic Aperture Radar (PolSAR), the relationship between the contour of targets and their corresponding dominate scattering type is preliminary researched. Then a novel target contour information extraction method based on the physical scattering mechanism of terrain targets is proposed, which is more effective and adaptable due to the scattering mechanism of terrain targets do not depend on the radar backscattering intensity, but its proportion among different polarizations. After applying to E-SAR airborne data, the results show that this method has a good capability to extract the target contour information. [C699]

"Hardware-accelerated edge detection for polarimetric synthetic aperture radar data"

From the literature review, there are two constant false alarm rate detectors for detecting edges in multi-look fully polarimetric synthetic aperture radar (POLSAR) imagery, namely the likelihood ratio edge detector and the Roy's largest eigenvalue-based edge detector. In the latter approach, one major restriction is the computation complexity, i.e. in the context of the chosen C language-based implementation. Thus, in this paper, a novel hardware-based architecture is presented to improve the processing time for the Roy's largest eigenvalue-based edge detection. The algorithm was implemented in a field-programmable gate array (FPGA) with an accelerated solution targeting data rates of up to 1 Gb/s. Its performance was examined using nine-look NASA/JPL C-band data and evaluated in terms of processing speed and accuracy as compared to the C language-based implementation on a personal computer (PC) with a CoreГ‚Вї 2 Duo processor clocked at 2.2 GHz. [C700]

"Higher order statistics applied to image segmentation"

Recent research has shown that image segmentation, has a great importance in many areas and especially in the industrial application, such as robot animation, mobile localization, etc...Г‚В¶ Also, in medical imaging, it is used for tumor detection and in radar imaging, it is used for target detection. This paper deals with the problem of texture segmentation using higher order statistics. We propose a novel form of the third order statistics, extend the general concept of the cooccurrence matrix, and define a frequency matrix. First order, second order and third order statistics are analysed and applied on examples related to image segmentation. It is shown that third order statistics provide higher performance and better segmentation results than other methods. The experimental results are handled on twelve Bordatz textures images and then the obtained results are evaluated on using (i) first order statistics using gray level matrix, (ii) second order statistics using co-occurrence matrix and (iii) the third order statistics using frequency matrix. The experimental results demonstrate the importance of using the high order statistic in texture characterisation for image segmentation. [C701]

"Deletion of the signal in direct way by clean analysis in a system of coherent passive detection"

The purpose of a system of coherent passive detection is to get back the echo resulting from the reflection on the target to detect. The method by clean analysis based on the projection of signals in an orthogonal sub-space in the direct signal allows preventing the problem of interference which engenders the presence of the signal in direct way in this type of system of detection. In the case of the presence of an echo and a direct signal, the study of the distribution of the powers of every signal by the analysis of the variation of the clean values according to the mnuber of elements of the network of antennas or the number of sub-networks demonstrates that these signals remain quartered in their respective orthogonal sub-space without influencing in a important way the other sub-space. [C702]

"Generation of Pulse Compression Codes Using NSGA-II"

Pulse compression technique avoids the transmission of a signal having small pulse width and high peak power for better range resolution by transmitting phase or frequency modulated large pulse width signal having comparatively low peak power signal. This paper demonstrates an application of non dominated sorting genetic

algorithm-II (NSGA-II), a multiobjective algorithm, to generate biphase pulse compression codes from length 49 to 59. But the aperiodic autocorrelation function(ACF) of the phase coded signals contains range sidelobes which act as self clutter in radar target detection. The efficiency of these codes depends upon the energy content in the range sidelobes of their autocorrelation functions. Peak sidelobe level (PSL) and integrated side lobe level (ISL) are the two performance measures for pulse compression codes. A code is chosen for an application if the ISL and PSL value is within tolerable limits. In this work PSL and ISL are chosen as the objective functions for generating biphase code. [C703]

"Mono-Alphabetic Signal Design for Improved Target Detection in High Resolution Radar Systems"

In this paper an attempt has been made to evaluate the detection ability of mono-alphabetic sequences for the application to high resolution radar in presence of high dense additive noise environment. The performance of these sequences is evaluated in terms of their noise robustness, multiple target discrimination through coincidence detection and range resolution ability. Asymptotic figure of merit of proposed serially uncorrelated mono-alphabetic sequence are determined by employing exhaustive search algorithm rather than by analytical design. Hamming back-track algorithm is designed and used for optimization. The simulation results based on the outcomes of this design algorithm for poly-semantic sequences give improved noise robustness in HRR target detection compared to conventional pulse compression sequences. [C704]

"A Two-Level Estimation Approach for a Radar System"

In a radar surveillance system, both non-maneuvering and maneuvering conditions are usually existed during the tracking process. The computation of a radar system is complicated to track multiple maneuvering targets in real time. In order to assure the tracking accuracy in a tracking, a new estimation approach for a radar system is developed in this paper. The major concept of this approach is that the system uses two-level estimation algorithm based on Kalman filter equations in a radar tracking system. In this paper, we convince that the new estimator can track maneuvering targets well. [C705]

"A Method for Recovering Maneuver Targets Spectra Based on the Algorithm of Decontaminating Ionospheric Slow Phase-Path Disturbance"

Both ionospheric slow phase-path disturbance and targets' maneuver will make the targets' echoes broaden in HF radar. Although their mechanism to spread the spectra is different, they are consistent on the view of the phase of targets' echoes. Using the algorithm of ionospheric disturbance decontamination which has been successfully applied in practice, a method for recovering maneuver targets spectra has been presented in this paper. Results of experimental data of HF radar and meter-wave radar verify the correctness of such process. And they also show that the algorithm can effectively improve the quality of the targets spectra to improve the radar target detection and tracking performance. [C706]

"A Least-Squares Algorithm for Maneuvering Targets in HF Radar"

In this paper, a motion-correction algorithm for maneuvering targets (acceleration or turning) whose spectra of the HF radar echoes are significant spread is addressed. Such spreading which degrades the detection performance and parameters estimation of targets originates from the high-order time terms of the echoes' phase. The least-squares method has been used to estimate these terms to correct the Doppler spectra for restoring the targets' peaks. Simulation and experimental data results show that such technique is helpful to achieve the better targets' spectra and the higher probability of detection. [C707]

"Detection subsurface hyper-saline soil in Lop Nur using full-polarimetric SAR data"

This paper presents the research results about Lop Nur using full-polarimetric technology. Lop Nur Lake is one of the driest places in the world and finally lost its last drop of water in 1972. It is well known for its Г,ВїEarth EarГ,Вї feature in optical remote sensing images. Likewise, Г,ВїEarГ,Вї feature is shown in Synthetic Aperture Radar (SAR) images, and even larger because of penetration effect. With the penetration capability SAR is capable of detecting the subsurface targets and materials, especially in arid environment. As for SAR images, both C-band and L-band, there are two key features about Lop Nur area. One is the whole Lop Nur area is high-bright that means the backscattering is much stronger than other sites, such as Gobi, desert and so on. The other feature is the Г,ВїEarГ,Вї pattern formation. polarimetric analysis about these two questions will be conducted based on past research results and field investigations. [C708]

"Subsurface microwave remote sensing and scattering modelling on hyper-saline soil: Example of Lop Nur"

Subsurface microwave remote sensing is a direction of Synthetic Aperture Radar (SAR) research. With the penetration capability, SAR is capable of detecting the subsurface targets and materials, especially in arid environment. Lop Nur Lake is located at the east of Tarim Basin in Xinjiang province of China, which is described as Г‚Вїdry coreГ‚Вї of the world, and it can provide conditions for SAR penetration. This paper presents preliminary analysis about Lop Nur, and gives out an abstract subsurface structure about it. Then, the major scattering processes are concluded and a two-layer scattering model is developed. Based on parameters of soil samples, some rules about Lop Nur evolution will be figured out. With Genetic Algorithm (GA), an inversion procedure is constructed. All the attempts are viewed as the basis of future comprehensive interpretation about Lop Nur phenomenon. [C709]

"Needs and applications for data mining in large series of remotely sensed images"

Recent years have shown an increase in image availability at decreasing cost, as focus changed from Г‚Вїmaximum profitГ‚Вї to Г‚Вїmaximum useГ‚Вї. This puts analysis and mining of time series of images within reach of a wider audience, promoting development of suitable techniques. This paper focuses on four generic types of mining of large series of images: a) presence and location; b) temporal patterns; c) spatio-temporal patterns; d) moving objects. For each type it is described which group of algorithms are used for mining and how uncertainty can be modeled. The four generic types can be used to find adequate algorithms for data mining and to describe uncertainty for new applications. Further developments are to be expected for tracking of fast moving objects, image mining of mixed archives and irregular time steps. Communication tools for uncertainty in image mining, targeted at users outside the geo-information sciences should be further developed. [C710]

"Using permanent scatterer InSAR to detect land subsidence and ground fissures: A case study in Xi'an city"

The Permanent Scatterers (PSs) SAR Interferometry has become an operational tool in the context of spaceborne SAR interferometry for monitoring surface deformation with millimetric accuracy. In this contribution we presented a case study in Xi'an city for land subsidence monitoring and ground fissures detection by using PS InSAR. We applied a linear regression model to retrieval land subsidence velocity by using a series interferometric phase of the coherent target. For the displacement of ground fissures monitoring, which caused by the nonuniform displacement of land subsidence and fault motion, a time series interferometric analysis of coherent target has been carried out to retrieve the history of displacement. The results archived from ENVISAT ASAR images acquired from 2005 to 2008 has demonstrated the distribution and the magnitude of the land subsidence and ground fissures. We compared the result from PS InSAR with the field surveying data and the results shown good agreement. [C711]

"Wiener prediction-based change detection for locating mines in multilook SAR imagery"

In this paper, we present a Wiener-based change detection method and compare its performance with several other methods for a pair of multi-look synthetic aperture radar (SAR) images of the same scene. We implement and compare several techniques which vary in complexity. Among the simple methods that are implemented are differencing, Euclidean distance, and image ratioing. These methods require minimal processing time, with little computational complexity, and incorporate no statistical information. We also implemented methods which incorporate second order statistic calculations in making a change decision in efforts to mitigate false alarms arising from the speckle noise, misregistration errors, and nonlinear variations in SAR images. These methods include a Wiener prediction-based method, Mahalanobis distance measure and subspace projection method. We compare the performance of these methods using multi-look SAR images containing several targets (mines). We present results in the form of receiver operating characteristics (ROC) curves. [C712]

"Distributed targets detection based on local spectral histograms and agents"

To detect the distributed targets in SAR images of the sea, an algorithm based on local spectral histograms (LSH) and agents is proposed. The filter banks consist of the intensity filter and 36 Gaussian derivative filters at 6 orientations and 3 scales. After picking out the background images of the sea, the distribution of the difference value based on LSH is obtained. Given a probability, a threshold is achieved which will be used in judging behavior of the agent. Then an agent system is proposed, and a group of behaviors are introduced, including judging, moving, communicating, breeding, inheriting and dying behaviors. So the detection could be performed through the evolution of the agents. Several examples show that our algorithm is effective for different distributed targets. [C713]

"Polarized point scatterers: An algorithm for detection using ALOS-PALSAR data"

This paper deals with a new class of localized point targets we call polarized point scatterers (PPS). They can

be detected from Quadpol SAR data by using a two-dimensional filter, employing an eigenvalue/alpha threshold. They can then be used to estimate the dielectric constant of the target using a simple scattering model. We first consider the basic performance of the filter based on selection of thresholds and data window size to keep false alarms to a desired low level. We then illustrate application of the filter to sample data sets from the ALOS-PALSAR archive, showing its important application to urban areas. [C714]

"Operational approach for ship detection and classification"

The necessity to control all the activities within the marine environment is nowadays vital for most official authorities. Besides protecting the ecosystem and providing safety and surveillance along the transportation corridors, illegal immigration and sustainable economic activities are also issues to cover. Since early nineties, a lot of efforts have been devoted to develop monitoring systems based on transponders (VMS or AIS). Such systems use active on-board devices to track ship positions via satellite communications. Despite of their great performance, the experience has shown, however, that this approach does not have the required independency and other alternatives are necessary. Among them, the one gathering more benefits is the integration of remote sensing, specially Synthetic Aperture Radar (SAR), with operational transponders. Certainly, this solution provides redundancy, 7/24 and all-weather monitoring capability, independently from the targets to track. [C715]

"Sea-clutter analysis at multiple wavelengths (L, C, X) for target-clutter contrast assessment in littoral waters"

This study is aimed at quantifying the statistics and nature of sea-clutter as seen from spaceborne platforms and assessing the target-clutter contrast in the Adelaide harbor area of South Australia. To this end a series of images in mixture of polarizations were collected over this area in typical wide area surveillance mode-ScanSAR single polarization images from TerraSAR-X, Dual-Polarization Wide Beam images from RadarSAT-2 and Full and Dual Polarization images from ALOS-PALSAR. Synchronized with the acquisitions (dawn/dusk orbit of SAR satellites) video over flights with a low light camera were performed to record the sea-state. AIS data was collected for the information on the larges vessels and meteorological buoy readings for surface wind, wave height and swell were noted. [C716]

"SAR target recognition based on sub-block statistical features extracted from the Gabor filtered image"

A method for SAR target recognition using low-frequency sub-band and Gabor filter sub-block statistical feature is proposed. The sub-band image extracted from the pre-processed SAR image is filtered by Gabor filter on different directions and scales. The each filtered sub-band image is divided into different sub-blocks and the statistical features derived from every sub-block of all filtered sub-band images are regarded as the target recognition feature, which can be used to recognize the targets with SVM. The proposed method is validated on MSTAR dataset for 3-type SAR target recognition. [C717]

"GRLT detection of moving target by along track SAR interferometric systems"

In this paper we consider the problem of the detection of a ground moving target using Synthetic Aperture Radar Along Track Interferometric (AT- InSAR) systems. We propose a method exploiting a Generalized Likelihood Ratio Test (GRLT) and based on a Gaussian model for the target response. We also derive the log-likelihood ratio probability density function in closed form, both in the hypothesis of presence of target and absence of target. Numerical results based on simulated data are presented. [C718]

"Chirp scaling based detection of moving targets in SAR images"

A moving target detection and high-resolution focusing scheme is presented for single-channel SAR systems. The moving target focusing is made of a bank of Chirp Scaling Algorithms (CSA), each one matched to a different along-track target velocity component, thus allowing to produce a high-resolution image of the target itself. The effectiveness of the proposed technique is shown with reference to a sample dataset obtained from a SAREX-92 image. [C719]

"Ship detection from polarimetric sar images"

SAR image from sea can constantly contain ships and their ambiguities in azimuth and range directions. For maritime applications, the ambiguities are visible due to their strong intensities in a low backscattering background of sea environment. Thus, the ambiguities can be often mistaken as ships and cause false alarms. Many approaches have been proposed for reducing the azimuth ambiguities in single channel SAR image. This paper analyzed scattering mechanisms of the azimuth ambiguities for PolSAR images and proposed a method

for detecting ships from PolSAR images. By using eigenvector-eigenvalue decomposition, three eigenvalues can be used to differentiate ship targets, azimuth ambiguities and sea clutter. One C-band JPL AIRSAR polarimetric data have been chosen to evaluate the method. The experimental results show that the proposed method can effectively reduce false alarms caused by the azimuth ambiguities. [C720]

"An experimental WiMAX based passive radar study"

Singapore has launched the world's first maritime WiMAX service network which also has introduced a new illuminator of opportunity for passive radar study. This paper presents a new study of passive radar using WiMAX signals. In this paper, the WiMAX standards, WiMAX-based passive radar demonstrator design based on a MIMO-OFDM testbed, and a primary field measurement for detecting ground vehicle are described. Interesting field measurement results may help us to understand the potential capabilities of WiMAX-based passive radar for range and Doppler detection and measurement of moving targets. [C721]

"Investigations into breast cancer detection using Ultra Wide Band Microwave Radar technique"

An experimental investigation into capabilities of an ultra wideband (UWB) microwave radar to detect breast cancer is presented. A phantom, consisting of a cylindrical plastic container with a low dielectric constant material imitating fatty tissues and a high dielectric constant object emulating tumour, is scanned over a circular cylindrical surface with an UWB probe antenna. Following the collection of an experimental data, spatial images of the breast phantom are formed using two different approaches. One neglects and the other one compensates for the signal drop with distance. The approach compensating for the received signal drop enables a successful detection of tumour targets with a diameter as small as 5 mm at different distances from the skin layer just by visual inspection of the produced image. [C722]

"RCS imaging measurement obtained by scanning parallel electromagnetic wave Beam using dielectric lens antenna"

RCS (radar cross section) imaging measurement was obtained by (1) scanning parallel electromagnetic wave beam using a dielectric lens antenna, (2) integrating the same phase signal by comparing the returning signals only relating to the reference signal, and (3) calculating RCS by comparing with a standard target. Using this imaging method, RCS measurements of an airplane with a 1.5 m wing span covered with aluminum film at 24 GHz was found to be within 5 dB of conventional far-field measurements. The features of the new method are as follows. (1) The measurement range is wide, between 2 m and 30 m. This measurement system can thus be used outside without an anechoic chamber. (2) Arrangement of the system is easy, particularly for use with a real airplane and other vehicles, owing to its compact size. (3) Partial RCS visualization is useful for improving areas with strong reflection in the developmental stages of airplane and other vehicle. [C723]

"Target detection in MIMO radar using Golay complementary sequences in the presence of Doppler"

In this paper, we present a method for detecting a point target using multiple antennas when the relative motion between the receivers and the target induces a non-negligible Doppler shift. As a key illustrative example, we consider a 4 ГґВ— 4 system employing a unitary matrix waveform set, e.g., formed from Golay complementary sequences. When a non-negligible Doppler shift is induced by the target motion, the waveform matrix formed from the complementary sequences is no longer unitary, resulting in significantly degraded target range estimates. To solve this problem, we adopt a subspace based approach exploiting the observation that the receive matrix formed from matched filtering of the reflected waveforms has a (non-trivial) null-space. Through processing of the waveforms with the appropriate vector from the null-space, we can significantly improve the detection performance. We provide simulation results to confirm the theoretical analysis. [C724]

"Linear FM radar operating in the Tera-Hertz regime for concealed objects detection"

Sub-millimeter and terahertz waves maintain reasonable penetration depth in certain common materials, such as cloth, plastic, wood, sand and soil. Therefore, THz radiation can detect concealed weapons since many non-metallic, non-polar materials are transparent to this type of radiation (and are not transparent to visible radiation). Target compounds such as explosives and illicit drugs have characteristic THz spectra that can be used to identify these compounds. Investigation, design and development of a sub-millimeter wave remote sensing RADAR system for homeland security applications are presented. The RADAR, operating at 330 GHz is based on transmission of a frequency modulated continuous wave (FMCW) and aimed at detection of concealed objects for ranges up to 20 m. The system consists of 2 horn-lens antennas integrated with a homodyne transceiver. The synthesized linear FM signal with a frequency span of 200 MHz at X-band is multiplied by a

factor of 32 to generate the transmitted Tera-Hertz wave. Using a splitter, the signal is fed to an antenna and to a local oscillator port of a second harmonic balanced mixer. As a result, an intermediate frequency signal is obtained, containing the information on the target. Distance measurements were made by performing data acquisition and signal processing commercial programs, resulting in a range resolution better than 1 cm. Preliminary Tera-Hertz imaging was also carried out to perform a three-dimensional image of the object. [C725]

"The predictability of anomalous propagation environments"

A correspondence is shown between anomalous sightings of ships by a weather radar with an upward tilted beam, and the existence of surface based ducts determined from numerical weather prediction (NWP) models. Since these forecasts are available several days in advance, the existence of such ducts can be predicted in advance. The parameters of these ducts are used in a propagation model to determine regions from which targets can be detected by the radar. Such regions were found to include those where ships were sighted by the radar. [C726]

"Characteristic study of ionospheric clutter in high-frequency over the horizon surface wave radar"

The presence of ionospheric clutter in high-frequency over the horizon surface wave radar may extremely affect the performance of radar system and degrade the capability of detecting target. The characteristic analysis of ionospheric clutter is the foundation of studying method to suppress ionospheric clutter. By using the MUSIC algorithm to analyze plentiful radar echoes data, directivity characteristic of several major kinds of ionospheric clutter has been summarized and the superposition situation that two kinds of ionospheric clutter exist at the same altitude has been discussed, moreover, the pertinence between directivity characteristic of ionospheric clutter and the working frequency has been studied. All these works provide convenience for advancing and realizing ionospheric clutter suppression methods based on directivity characteristic of ionospheric clutter. [C727]

"A set of triphase coded waveforms: Design, analysis and application to radar system"

Based on the zero correlation zone (ZCZ) concept, we present the definition and properties of a set of new triphase coded waveforms -ZCZ sequence-pair set (ZCZPS) in this paper and propose a method to use the optimized punctured sequence-pair along with Hadamard matrix construct the optimized punctured ZCZ sequence-pair set (optimized punctured ZCZPS). According to property analysis under the Doppler shift condition, the optimized punctured ZCZPS has good autocorrelation and cross correlation properties when Doppler shift is not large. We apply it to radar target detection. The simulation results show that optimized punctured ZCZ sequence-pairs (optimized punctured ZCZPs) outperform other conventional pulse compression codes, such as the well known polyphase code-P4 code. [C728]

"Power Delay Profile Matching for Vehicle Target Recognition"

Radar echo contains unwanted echoes called as clutter, which make it difficult to detect vehicle or obstacle. Especially short-range/wide-angle vehicle radar at 24 GHz suffers from heavy clutter unlike long-range radar at 77 GHz. It is therefore expect to improve the detection performance by suppressing the clutter using a pulse integration and CFAR (Constant False Alarm Rate). However the radar echo should include multiple vehicle targets as well as the clutter, thereby it is not easy to improve the performance. In this paper the target discrimination technique, let say, power delay profile matching scheme is proposed and the usefulness is investigated by conducting the measurement at 24 GHz where the clutter suppression scheme is also considered. As a result, a vehicle target is found to be recognized from multiple vehicles. We have also investigated the effect of bandwidth on the target discrimination capability. [C729]

"Passive Acoustic Sensor Network Time-Delay Probabilistic Localization Algorithm"

Target signal is measured by acoustic sensor with the character of time-delay and bearing-only. The problem of target locating and time-delay registration can be solved by composing sensor network. A passive acoustic sensor network time-delay probabilistic localization algorithm is presented in this paper. Firstly, two sensor measures can be chosen that intersection angle is closed to 90Г‚В° to get initial position of the target. Depend on the initial position, time-delay registration is processed, and then the measure data is refreshed which intersection angle is closed to 90Г‚В° to get new initial position estimation of the target. Finally, the new initial position is utilized to get more accurate estimation by probabilistic localization algorithm. The simulation results show that the algorithm has the performance of low calculation, real-time and high precision. [C730]

"Detection scene analysis for high frequency radar"

Suffering from multiform time-variant and fluctuant clutter in High Frequency Radar (HFR), uniform target

detection, tracking and clutter mitigation methods will result in false alarm or missing alarm. To select optimized detection and clutter mitigation method in the region of interesting, a method maximizing the separability of the resultant classes in amplitude of range-Doppler map is used for segmentation in multi-level detection background. Statistical and qualitative analysis is operated on the result of clutter extraction. Real data indicated that the proposed method can extract clutter region and adapt for various echo spectral maps for HFR as well, which can offer more accurate prior knowledge for target detection and clutter mitigation. [C731]

"Performance analysis of OSGO and OSSO CFAR detectors under pearson distributed clutter"

In this paper, the detection performance of OSGO and OSSO CFAR detectors embedded in heavy-tailed Pearson distributed clutter is analyzed. We derive the closed mathematic form expressions of probability of false alarm rate and detection probability of the two CFAR schemes. While the processing speed of OSGO and OSSO CFAR is two times of that of OS CFAR, simulation results indicate that OSGO CFAR detector's performance is very close to OS, and OSSO CFAR offers better and robust detection performance than OS CFAR in multiple-target situation. [C732]

"Optimal point target detection with unknown parameters by MIMO radars"

We consider multiple-input multiple-output (MIMO) radar systems with widely spaced transmit and receive antennas. We treat the problem of detecting point targets when one or more target parameters of interest are unknown. We provide a composite hypothesis testing framework for jointly estimating such parameters along with detecting the target while only a finite number of signal samples are available. The test offered is optimal in a Neyman-Pearson-like sense such that it provides a Bayesian-optimal detection test, minimizes the average mean-square parameter estimation error subject to an upper bound constraint on the false-alarm probability, and requires a finite number of samples. While the test can be applied for concurrently detecting the target along with estimating any unknown parameter of interest, we consider the problem of detecting a target which lies in an unknown space range and find the range through estimating the vector of time delays that the emitted waveforms undergo from being illuminated to the target until being observed by the receive antennas. We also analyze the diversity gain which we define as the rate that the probability of mis-detecting a target decays with the increasing SNR and show that for a MIMO radar system with Ntand Nrtransmit and receive antennas, respectively, the diversity gain is 1 for point targets. [C733]

"Study on MIMO radar detection performance"

Multiple input multiple output (MIMO) radar is a new radar technique. It has many advantages over conventional phased radar in many ways such as anti-intercept of radar signal, low velocity target detection, and resolution. In this paper, we analyze the signal model and signal processing for MIMO radar. And we compare the SNR of MIMO radar with that of conventional phased array radar. It can be seen that the SNR of MIMO radar is the same as that of phased array radar. [C734]

"FPGA-based implementation of a CFAR processor using Batcher's sort and LUT arithmetic"

This paper presents the realization of the forward automatic censored cell averaging detector (F-ACCAD), a novel CFAR algorithm for detecting targets in log-normal distribution clutter recently published . The algorithm is realized through an FPGA-based parallel architecture. The timing constraints of high resolution radar applications are considered and satisfied in the system. The sequential nature of the algorithm has been parallelized to achieve the desired processing delay. The intensive statistical calculations and the complexity of the algorithm have been significantly reduced by using lookup tables (LUTs). Batcher's sort, a parallel sorting algorithm, is adopted in this work. The hardware synthesis results and timing analysis are reported at the end. [C735]

"360°-Environment sensing and signal processing for an automotive pre-crash application"

In this paper a new and flexible 360Г‚В°-environment sensing system using short range radar sensors and active seat belt pretensioners is presented. To detect critical targets from a wide variety of closing angles, a total of only four radar sensors is used. The number of sensors can be changed, without altering the underlying sensor fusion and target detection algorithms. The challenges of pre-crash systems are presented and the multi-sensor fusion and signal processing algorithms are shown. To be able to react to highly dynamic driving maneuvers, an interacting multiple model filter (IMM) is used. A pre-crash algorithm for 360Г‚В°-environment sensing is introduced. To verify the system effectiveness, a simple, yet effective, system test has been developed. Test data is gained and evaluated for different critical situations. The presented pre-crash system serves as a basis for new driver assistance and safety functions, which helps to increase overall driving safety, even in dense traffic and urban driving situations. [C736]

"Efficient target identification for MIMO high-resolution imaging radar via plane-rotation-invariant feature"

Target identification has been an active researching area in past decades. In this paper, we present an identification method based on the high-resolution image from a narrowband multiple-input multiple-output (NMIMO) imaging radar system. Different from the traditional image-based method, the key idea of the proposed method is to build the plane-rotation-invariance features of a candidate target with its location parameters of 2-D scatterers, regardless of the amplitude information of a 2-D scatterer. Numerical examples are presented for testing our method. [C737]

"Particle filter algorithm for tracking manoeuvring target using FM signal"

In order to introduce the particle filter techniques in the passive radar detection and tracking, we present in this correspondence a comparison between classical technique of tracking that uses a maxima search in the range/Doppler grid-space, and then estimates the target position using an extended Kalman filter and a proposed particle filter that uses directly the correlation output. The passive radar receives the signals of FM stations that propagate and reflect on a manoeuvring target. [C738]

"Random Hypersurface Models for extended object tracking"

Target tracking algorithms usually assume that the received measurements stem from a point source. However, in many scenarios this assumption is not feasible so that measurements may stem from different locations, named measurement sources, on the target surface. Then, it is necessary to incorporate the target extent into the estimation procedure in order to obtain robust and precise estimation results. This paper introduces the novel concept of Random Hypersurface Models for extended targets. A Random Hypersurface Model assumes that each measurement source is an element of a randomly generated hypersurface. The applicability of this approach is demonstrated by means of an elliptic target shape. In this case, a Random Hypersurface Model specifies the random (relative) Mahalanobis distance of a measurement source to the center of the target object. As a consequence, good estimation results can be obtained even if the true target shape significantly differs from the modeled shape. Additionally, Random Hypersurface Models are computationally tractable with standard nonlinear stochastic state estimators. [C739]

"Multiple target detection using Bayesian learning"

In this paper, we study multiple target detection using Bayesian learning. The main aim of the paper is to present a computationally efficient way to compute the belief map update exactly and efficiently using results from the theory of symmetric polynomials. In order to illustrate the idea, we consider a simple search scenario with multiple search agents and an unknown but fixed number of stationary targets in a given region that is divided into cells. To estimate the number of targets, a belief map for number of targets is also propagated. The belief map is updated using Bayes' theorem and an optimal reassignment of vehicles based on the values of the current belief map is adopted. Exact computation of the belief map update is combinatorial in nature and often an approximation is needed. We show that the Bayesian update can be exactly computed in an efficient manner using Newton's identities and the detection history in each cell. [C740]

"Model based design flow for implementing an anti-collision radar detection system"

We have presented a novel design methodology to model complex intensive data-parallel applications. The modeling is carried out using the UML graphical language and the MARTE standard. Afterwards, automatic code generation can be carried out via MDE tools and technologies. Finally the code can be synthesized and implemented on a target FPGA. We have presented an example of this process, by building a correlation based delay estimator for a anti-collision radar system. We presented some results, and we have got very promising results. In perspective to our works we plane to made optimisations to optimization on the MDE tools and compare the performances of the generated code vs a hand made one. [C741]

"Performance analysis of poly-semantic sequence for high resolution Doppler radar"

Superiority of poly-alphabetic sequences (PAS) for pulse compression radar over the binary and ternary sequences was established earlier. However, the enlarged alphabets in poly-alphabetic sequences deteriorate the noise and Doppler robustness at higher lengths in high resolution radar (HRR) systems. In this paper, poly-semantic sequences (PSS) with restricted alphabets {+1,-1} are considered and their performance is analyzed in order to achieve superior detection performance for high resolution Doppler radar system in presence of high density additive noise and Doppler shift. The poly-semantic sequences are optimized by employing modified Hamming scan algorithm called Hamming backtrack algorithm (HBT) by taking figure of merit as the measure of

goodness. The detection capability of poly-semantic sequences is further improved through coincidence detection of the return signal. The simulation results show that the proposed sequences give improved robustness of noise and Doppler shift for HRR target detection compared to conventional pulse compression sequences. [C742]

"Design of a Timing Signal Generator (TSG) for RADAR Using FPGA"

The paper discusses the application of VLSI technology to implement the functions of TSG of a radar system using VHDL with behavioral model, as the HDL and targeting it to a FPGA. The TSG is the heart of radar application to generate timing and control signals to operate radar in different phases like detection, tracking and acquisition, and hold mode. The advantage of TSG design with FPGA is that TSG unit assembly gets mounted into a single chip, parallel processing is done and changes at the hardware are possible through programming from remote without consumption of time and money. [C743]

"Use of contextual information by Bayesian Networks for multi-object tracking in scanning laser range data"

This paper presents a new method to improve the perception of the environment of a vehicle. The aim here is to detect the vehicles using a scanning laser range finder and track the detected objects at each time. This contribution can be considered as an element of a global vehicle-to-vehicle (v2v) surveillance system where the on-board system receives warnings from the other local systems. It allows to extend the effective surveillance field and as a consequence to provide a faster reaction of the vehicle (collision avoidance or mitigation). To deal with this multi-target tracking problem, we focus on the Joint Probabilistic Data Association (JPDA) methods. Their particularity lies in their ability to take into account the probabilistic characteristics of the detector (detection and false alarm probabilities). Whereas in many works the detection probability is set up once, our contribution is to propose a method that dynamically estimates for each object the detection probability using the contextual information modeled by a Bayesian Network (BN-JPDAF). [C744]

"Strategies for FMCW radars"

In this paper, we present a comparison of two strategies for FMCW radars. The potential presence of multiple targets implies using specific waveforms for beat frequencies association. Here, we compare performance of two such waveforms in terms of targets distance and velocity estimation. Our comparison, based on theoretical bounds derivation is validated by Monte Carlo simulations. In particular we show that Barankin variance bounds yields conclusions that are in good agreement with results of simulation experiments. [C745]

"Target tracking in the time-frequency domain for a driving aid application"

Driving aid is an important emerging radar application. Among associated technological issues, detecting and tracking potential obstacles (cars, pedestrians, static objects ...) is of key interest. In this context, we propose an original tracking method, based on particle filtering, where the observation of the state vector is the cross-ambiguity function of the backscattered signal. Simulations for various waveforms demonstrate the improvement brought compared to the conventional approach, in which a detection step precedes the tracking. [C746]

"Selectable target detector using the polarization fork"

A new target detection methodology is described that makes novel use of the polarization fork of the target. The mathematical formulation is general and can be applied to any kind of single target as long as its expression in the target space is known. Aim of this paper is to present a standard procedure to set the detector parameters for any target of interest. The algorithm makes use of the Gram-Schmidt ortho-normalization in order to set the appropriate basis for the polarimetric space. Validation against real data shows significant agreement with the expected results based on the theoretical description. [C747]

"Range resolution of unequal strength targets"

This paper examines the problem of resolving targets whose amplitudes may differ. A common metric used for resolution that assumes targets of equal strength is modified for the subject scenario. An expression for range resolution that accounts for the difference in target strength is also developed. Computational results are presented to depict how resolution performance is affected by various parameters. [C748]

"Low-observable target detection in sea clutter based on fractal-based variable step-size least mean square algorithm"

This paper introduces fractal-based variable step-size least mean square(FB-VSLMS) algorithm and proposes a

model for radar target detection in sea clutter. FB-VSLMS algorithm deals with a specific class of fractal signals and except one parameter requiring time-varying constraints, the constraints on the remaining parameters are time-invariant. And the step-size matrix is determined completely with the knowledge of the deterministic Hurst exponent. The model based on this algorithm is suited for tracking signals from the family of fractal signals that are inherently nonstationary. In the end, the performance of the novel model is analyzed. By the verification of X-band real sea clutter, the model is shown to be effective for low-observable point target detection in sea clutter. [C749]

"UHF alerter intended for the protection against mortar"

Detection of rocket and mortar firings, evaluation (calculation) of launching and impact points, then warning of troops deployed in the likely impact area are now major causes for concern for our forces in a theatre of operation. It is vital to seek out a solution offering a sensor for the protection against mortar in the short run. A radar alerter operating in UHF band could meet this requirement. Small targets (such as 60 mm rounds) could be detected depending on the emission of a low power because of the optimization of the RCS with regards to this frequency band. [C750]

"Study of effect of room window on through wall imaging in UWB range"

In through wall imaging (TWI), detection is possible due to dielectric contrasts between target and room environment. Complexity increases if room consists of furniture's and other objects beside desired target. Further detection of desired target becomes complex with the presence of window in back wall of room. Thus in this paper, effect of presence of window in back wall of room is investigated on detection and imaging. A detection technique is proposed in which signal processing technique is applied to extract the target information from clutter signal. A back projection imaging technique is applied to image the target. For this purpose, indigenously a TWI system based on step frequency continuous wave (SFCW) principle is developed in ultra wide band (UWB) range of frequency (i.e., 3.95 GHz to 5.85 GHz), plywood considered as wall and metallic plate is considered as target behind the plywood wall. The results are quite encouraging. [C751]

"Multiple target Doppler estimation under possibly moving radar clutter"

Multi-target detection for pulsed Doppler radars under land/moving clutter characterized by antenna scanning modulation is analyzed using linear prediction based Tufts-Kumaresan's method. Comparison between this method and other line spectra estimation algorithms such as MUSIC and ESPRIT is performed. A technique to determine the model order required by the frequency estimation algorithms, which does not distinguish between targets and clutter, is presented. The clutter region concept is then introduced to identify targets from the clutter. [C752]

"A novel moving target indication strategy for traffic monitoring using SAR"

This paper presents a novel moving target indicator which is selective with respect to a direction of interest. This selectivity may be useful for traffic monitoring in civil environments where the target area contains, simultaneously, traffic moving in several different directions, besides that of interest. The developed MTI obtains results more accurate than those obtained by the classical methods. Furthermore, it has low computational requirements and provides accurate results using data from single channel SAR.. [C753]

"On MIMO waveform design for non-Gaussian target detection"

We consider a multiple-input multiple-output (MIMO) detection problem with M widely-spaced transmit antennas and L widely-spaced receive antennas (not necessarily co-located), and we study the problem of designing the signal waveforms transmitted by each source node under non-Gaussian target scattering and temporally-correlated Gaussian clutter. Two figures of merit are investigated for space-time code optimization under a semi-definite rank constraint and a received signal-to-clutter ratio constraint: 1) the lower Chernoff bound (LCB) to the detection probability for fixed probability of false alarm, and 2) the mutual information (MI) between the observations available at the receive nodes and the МГґВ—L Г‚Вїchannel matrixГ‚Вї generated by a target, assumed present tout court. If the scattering distribution possesses some suitably defined properties of exchangeability and unitary invariance, we show that MI-optimal and LCB-optimal space-time coding admit a simple closed-form solution. Finally, a case study of relevant practical interest is examined in depth so as to compare the proposed design criteria and to assess the impact of signal non-Gaussianity on the detection performances. [C754]

"Detection and direction finding performance of hybrid bistatic radar"

The conventional phased-array radar provides coherent processing gain while the MIMO radar exploits spatial diversity gain to improve the system performance. We investigate a hybrid bistatic radar combining these two configurations to take advantage of both gains. The probability of detection of the hybrid system is derived, and the CRB and the MSE of the maximum likelihood estimation for both angle of departure and angle of arrival are evaluated to assess the direction finding performance. [C755]

"A radar signal simulator for DAB based passive radar"

This paper describes a simulator for a digital audio broadcast (DAB) based passive radar system. Sample scenarios comprising a receiver, a target and several illuminators are given. DAB transmission signals are simulated, and an estimate of the signal arriving at the receiver is calculated. The received signal is made up of weak target returns and strong direct signal interference (DSI). Simulated autocorrelation and cross-correlation displays are given. [C756]

"Probability distribution mixture model for detection of targets in high-resolution SAR images"

In this paper, the detection of close targets in heterogeneous clutter in high-resolution SAR images is investigated. We adopt a probability distribution mixture model where each pixel intensity image is characterised by two probability density functions: one related to the targets and one related to the background clutter. A specific detection threshold, based on the estimates of the mixture parameters, is used. The statistical characterisation of SAR images modeling is a key issue for detection. The clutter is modelled using the K distribution that is a flexible tool over non-homogenous areas. We show that our method is able to detect close targets at constant false alarm ratio without making any assumptions about their size and their spatial configuration. [C757]

"Sea Spikes Suppression for high range and high Doppler resolution radars"

High resolution in range and Doppler are recommended to border surveillance X-band radars for the detection of small RCS ground targets in a severe clutter environment. This kind of radars can also be employed for sea border control. However, in this case the radar processor should suppress the sea spike echoes that can be otherwise mistaken with small boats. In this paper a solution for mitigating the problem connected with sea spikes is proposed. A 2D CFAR that uses the information from both the range and Doppler characteristics of the echoes is presented. The performance of this algorithm is compared with the one of a classical CFAR which can instead be efficiently employed in a ground environment. [C758]

"Space-time adaptive algorithms for track-before-detect in clutter environments"

In this paper we propose and assess TBD strategies for radar systems adopting STAP. At the design stage we consider a radar system equipped with a linear array of Nasensors that illuminates the surveillance area by transmitting M coherent pulse trains, each consisting of Nppulses, before deciding whether or not a target is present over L adjacent range cells. As a preliminary step we introduce the target and noise models. Then, resorting to GLRT and ad hoc procedures, we derive adaptive CFAR detectors for both stationary and scan-to-scan varying clutter scenarios (a point better clarified in the body of the paper). The proposed detectors guarantee the CFAR property with respect to the unknown spectral properties of the clutter. The preliminary performance assessment, conducted resorting to Monte Carlo simulation, shows that proposed procedures might be a viable means to implement early detection and track initiation of weak moving targets. [C759]

"Bat-pollinated plants: feature extraction for target recognition in the natural world"

In recent years, with the development of high range resolution radars, the desire to be able to identify targets under all weather and clutter conditions has become of great importance. Bat-pollinated plants have evolved flowers to ease classification by nectar feeding bats even in a dense clutter environment. In this paper we analyze three real images of a Cobaea scandens corolla. These were collected by means of an acoustic radar capable of very high range resolution. The features of these flowers that allow high classification performance by bats are exploited. Results are discussed and related to the task of classification in radar systems. [C760]

"Polarimetric MIMO radar with distributed antennas for target detection"

Distributed antenna radar systems provide spatial diversity gain by viewing the target from different angles. Polarimetric radar offers improved performance over conventional radar systems by exploiting polarization diversity. We propose a radar system that offers both spatial and polarimetric diversity gains for detecting stationary point-like targets. The receive antennas of the proposed system use 2D vector sensors, each measuring the horizontal and vertical components of the received electric field separately. We design the

Neyman-Pearson detector for this proposed system and analyze its performance. This analysis is used to select the optimal transmit polarizations for this system. Using simulations, we demonstrate the improvement offered by the optimal choice of polarizations. We also show the spatial diversity offered by MIMO radar. [C761]

"On MIMO radar transmission schemes for ground moving target indication"

We compare several multiple-input multiple-output (MIMO) radar transmission schemes, including code division, time division and Doppler frequency division multiplexing approaches, for ground moving target indication (GMTI). To utilize probing waveforms with low sidelobe levels for range compression, we transmit sequences specifically designed to have low correlation levels. At the receiver side, we apply the iterative adaptive approach (IAA), which uses only the primary data, to form high resolution angle-Doppler images. To mimic real world scenarios, we apply our algorithms to a simulated dataset which contains high-fidelity, site-specific, simulated ground clutter returns. By combining the usage of intelligent transmission schemes, probing waveforms with good correlation properties, and the adaptive angle-Doppler imaging approach, we show that slow moving targets can be more clearly separated from the clutter ridge in the angle-Doppler images and potentially more easily detected by MIMO radar than by its conventional single-input multiple-output (SIMO) counterpart. [C762]

"Finite-sample optimal joint target detection and parameter estimation by MIMO radars"

We consider MIMO radar systems with widely-spaced antennas. We treat the problem of detecting extended targets when one or more target parameters of interest are unknown. We provide a composite hypothesis testing framework for jointly detecting the target along with such parameter estimation while only a finite number of signal samples are available. The test offered is optimal in a Neyman-Pearson-like sense such that it offers a Bayesian-optimal detection test, minimizes the average maximum likelihood parameter estimation error subject to an upper bound constraint on the false-alarm probability, and requires a finite number of samples. While the test can be applied for concurrently detecting the target along with estimating any unknown parameter of interest, we consider the problem of detecting a target which lies in an unknown space range and find the range through estimating the time delays that the emitted waveforms undergo from being illuminated to the target until being observed by the receive antennas. We also analyze the diversity gain which we define as the rate that the probability of mis-detecting a target decays with the increasing SNR for a controlled false-alarm and show that for a MIMO radar with Ntand Nrtransmit and receive antennas, respectively, the diversity gain is NtГ‑B— Nr. [C763]

"Design and implementation of multi mode Radar Target simulator using Direct Digital Synthesizer"

Idea of Hardware Radar simulator is to electronically generate the Radar illuminated environment without switching on actual Radar transmitter in the field. This paper describes the implementation of Radar Target simulator using advanced technology of arbitrary waveform generator (Direct Digital Synthesizer chip) & FPGA. The Radar Target Simulator has the advantage of measuring of system response, evaluating and optimizing the performance of radars without expensive field trips to harsh regions and can be used to test the radar without interfering with commercial wireless devices. It replicates the feed-through signal between transmit and receive antenna for CW Radar, Conventional Pulsed Radar (with pulse width >70ns) and LFM Pulse Compression Radar. In each mode it accurately generates phase-coherent transmit pulses & simulates target echoes (replication of transmit pulse) with following programmable parameters; (a) Target range by time delay (b) Doppler shift to simulate moving target through phase control of pulses (c) Signal strength to simulate SNR target echoes With the above mentioned salient features this Target Simulator can be used to develop and test Radar Algorithms e.g. Digital Receiver/Pre-processing, Pulse Compression Algorithm, Target detection, Range calculation/range resolution test up to 10m, Doppler Processing and tracking of single or multiple targets. Hence, operating in the 10 to 170MHz range, the target simulator is well-suited to the task of generating multiple phase-coherent signals in the IF range. The output is also compatible with frequency converters, which extends useful operation into the RF realm. The prototype can operate in a stand-alone configuration and can be used for algorithm development, testing and evaluation of the radar in the laboratory. [C764]

"Sensor scheduling with waveform design for dynamic target tracking using MIMO radar"

Multiple-input, multiple-output (MIMO) radar systems have gained significant attention as they can enhance target detection, identification and parameter estimation performance. In this paper, we consider the problem of optimizing the target tracking performance of a widely-separated MIMO radar system by scheduling the transmitter sensors and adaptively designing their waveforms. Specifically, for a tracking scenario consisting of a large number of MIMO radars, we propose: (a) a transmitter scheduling algorithm to achieve tracking performance gains based on resource constraints; and (b) an adaptive waveform optimization algorithm that further improves tracking performance. Under an ideal receiver assumption, we evaluate the predicted tracking

mean-squared error using the derived CrameГ‚Вїr-Rao lower bound (CRLB) on the estimation of the target states. The scheduling algorithm is then formulated as a mixed boolean-convex optimization problem to minimize the CRLB. The optimum waveform parameters are adaptively obtained using sequential quadratic programming. The effectiveness of combining the MIMO radar technology with adaptive waveform design and sensor scheduling was demonstrated with simulations. [C765]

"Target detection in MIMO radar using Golay complementary sequences in the presence of Doppler"

In this paper, we present a method for detecting a point target using multiple antennas when the relative motion between the receivers and the target induces a non-trivial Doppler shift. We consider a 4 ГґВ— 4 system employing sets of unitary waveforms. In case of a non-trivial Doppler shift induced by the target motion, the waveforms are no longer unitary, and unambiguous target ranging is not possible. To solve this problem, we adopt a subspace based approach where we show that the unitary waveforms used have a non-empty null-space under certain conditions, and by processing the waveforms with vectors from the null-space, we can significantly improve the detection performance. [C766]

"Exploiting correlation in target detection using MIMO radar with angular diversity"

Multiple-input multiple-output (MIMO) radars utilize multiple waveforms simultaneously to improve performance. A MIMO radar in which angular diversity is achieved by using widely distributed antennas has been proposed before. This type of system is also known as the statistical MIMO radar. Typically, it has been assumed that the signals received by different antennas are either fully correlated or independent depending on the configuration. We make a more realistic assumption of partially correlated scattering from the target. In this paper, we show that taking the correlation of the scattered signals into account can improve the probability of detecting the target. It is shown that the scattering statistics do not need to be known, but can be estimated reliably from the received signal if a certain type of scattering model is assumed. In this paper, the GLRT using the maximum likelihood estimates of the unknown parameters is proposed for target detection. [C767]

"Hidden Markov Model for target tracking with UWB radar systems"

In this paper we demonstrate the application of Hidden Markov Models (HMM) for localization and tracking in ultra wide band (UWB) radar networks. To improve localization, a Voronoi region based approach is utilized to form a HMM for detection and tracking of mobile target. The observations used for the HMM localization are obtained from the power delay profile of the received signals. In UWB systems the use of entire power delay profiles instead of the total power only, allows to reach higher localization accuracy. This is due to the power delay profile being a measure of the power as well as the time of arrival. Simulation results suggest a performance gain of 7dB over the maximum likelihood estimation for localization in presence of path loss at intermediate values of signal to noise ratio (SNR). [C768]

"Moving target detection with MUSIC for the bistatic radar using digital broadcasting signals"

In the bistatic radar using broadcasting signals, the delays between signals propagated directly and scattered by the target are measured to estimate the target position with cross-correlation. This results in the delay profile with the width limited by the bandwidth of the signal. To get better resolution, larger bandwidth is required, however, the bandwidth of broadcasting signals can not be increased by the receiver. In this paper, we propose a new method of the moving target detection with MU-SIC (MUltiple SIgnal Classification), processed at only receiver. That offers much narrower width than that of cross-correlation. The proposed method can distinguish the moving targets from the stationary targets, though the conventional MUSIC can not. This is realized by the decorrelation of the time delay-derived phase rotation factors caused by moving targets. The performances using ISDB-T (Integrated Service Digital Broadcasting -Terrestrial), the bandwidth of which is 5.57 MHz, are evaluated by the computer simulations. The results show that two close moving targets, separated by 0.1 Г‚Вїs, with SNR=-10 dB each can be resolved even if the stationary target is located around the one moving target. [C769]

"Generation of three dimensional photo-realistic models from Lidar and image data"

Light detection and ranging (Lidar) instruments collect high density and accurate three dimensional (3D) point clouds of scanned surfaces of objects. 3D building modelling from terrestrial Lidar requires the raw point cloud data to be processed. Through processing, noise and outliers are eliminated from the point cloud, and a 3D photo-realistic model is generated using image data. This effectively reduces redundant data and enhances the visual representation. This paper deals with point cloud processing and proposes methods to automate several of the processing procedures. Specifically, we implemented automatic 3D point cloud registration, automatic target recognition used for geo-referencing, automatic plane detection algorithm used for surface modelling, and

texture mapping. The proposed approach leads to the generation of accurately geo-referenced three dimensional (3D) photo-realistic models from point clouds and digital imagery. [C770]

"Spectral estimation for clutter processing in digital radars by Dimension-Adaptive Particle Swarm Optimization (DA-PSO)"

Power spectrum estimation from radar data is essential for target detection. For instance, microburst causes detrimental effects on airplane performance, and hence its detection is critical. We compare auto-regression (AR), Periodogram, Kaiser windowed Periodogram, and multiple-signal-classification (MUSIC) methods for microburst clutter spectrum estimation. Given a long train of returned signal, we are able to segment the signal to obtain multiple estimations of the parameters, which leads to a more accurate estimation after coefficient averaging. The estimated power spectrum is then integrated for clutter magnitude calculation to determine whether a target is present at certain cell. The magnitude of clutters in an ensemble from a wide region spatially or through time temporally is used to estimate the clutter map. We choose a K-distribution mixture model over the traditional Rayleigh distribution to better approximate the tail structure of the distribution to minimize the false alarm rate. We show that Dimension-Adaptive Particle Swarm Optimization (DA-PSO) is robust to sample size in estimating the K-distribution mixture model, which is desirable for real-time implementations. [C771]

"Anderson-Darling Test based CFAR Detection"

An Anderson-Darling(A-D) test based CFAR detector feasible for multiple interfering targets and clutter edge scenarios is proposed and referred as AD-CFAR, which exploits K-sample A-D hypothesis test technique to censor clutter blocks needed for power estimation. Thereafter, AD test is employed for distribution test of the resultant homogenous blocks to select the proper detection algorithm from strategy library composed by the ready-made cell-average (CA), great-of (GO), Log-t detectors. Theoretical analyses indicate that the proposed AD-CFAR outperforms conventional CFAR detectors in non-homogenous clutter while maintains similar performance in noise-only scenario as CA-CFAR. [C772]

"Study on Ship Target Detection and Recognition in SAR imagery"

Analysis the characteristics of SAR ship target detection and identification. Summarize and divide the commonly used features into three categories: spatial features, transform features and the moving feature. The general ship detection and identification process is discussed in details. The development of SAR ship target detection and identification are surveyed and the mainstream approaches are listed. The main problems on ship detection and recognition process have been described as well. Finally a possible development direction of SAR ship target detection and recognition is given. It is expected that the researchers will obtain useful information from this paper, which will help for their future works and promote the SAR image target detection and recognition of ship development. [C773]

"Detection performance of MIMO radar with realistic target models"

We simulate a multiple-input multiple-output (MIMO) radar system involving a realistic target, which is a life-size land vehicle modeled using a EM simulator FEKO. Numerical results showing the detection performance of a MIMO radar are provided, which is measured based on multiple realizations of the channel matrix generated using the available FEKO data. The results validate in a practical setting the improvements in detection performance available from MIMO radar configurations. [C774]

"Airborne Radar and shipborne sonar: Recent advances and compared solutions"

The detection of slowly moving target in a strong backscattering background (clutter for radar, reverberation for sonar) is a challenge to both Airborne Radars and Surface Ship or Submarine Sonars communities. In this paper, after outlining the similarities and differences between the above and under-water domains, recent advances in the areas of waveforms design and beam-forming will be described. In a first part, more efficient wide-band Doppler waveforms for sonar will be introduced together with their advantages in terms of detection, and wideband coherent waveforms for radar moving targets detection will be presented. The second part will focus on the implementation of adaptive beam-forming for sonar and coloured transmission space time beam-forming for radar. Results on reverberation reduction obtained on a towed array sonar in CW mode will be discussed, and perspectives for coloured transmission radar systems will be outlined. [C775]

"New polarimetric SAR processors based on signal and interference subspace models"

We develop in this paper new polarimetric SAR processors based on signal and interference subspaces model. These processors aim at using models with physical and polarimetric scattering properties not exploited by the

isotropic point model. Our goal is to increase the response of the target and decrease the response of the interferences. These processors are implemented by computing the corresponding target and interference subspaces. Results on FOPEN simulated data with realistic target show the interest and the limits of these new processors. [C776]

"Modelling X-band sea clutter with the K-distribution: Shape parameter variation"

Performance modelling techniques for maritime radar target detection problems typically make use of a parametric probability distribution for the background ocean backscatter. In this paper, measured X-band sea clutter is analysed by fitting a K-distribution and the variation of its parameters with radar resolution, polarisation, viewing grazing and azimuth angles and ocean wind and wave conditions is examined. Grazing angles lie in the range 10Г‚В° to 45Г‚В°. Earlier work has already characterised the variation in the mean of the distribution. Here, the shape parameter Г‚Вї is studied. Surprisingly, it is found that Г‚Вї exhibits a sinusoidal like variation with azimuth angle which is aligned with the direction of the wind waves rather than the swell. [C777]

"Detecting 3-D rotational motion and extracting target information from the principal component analysis of scatterer range histories"

ISAR imagery of ships are complicated by the 3-D motion of the target, which causes blurring in the imagery. A technique is proposed which could help detect such motion and prove useful to both analyse the 3-D motion as well as possibly help to estimate the 3-D position of scatterers as a by-product of the analysis. The technique is based on principal component analysis of accurate scatterer range histories and is shown only in simulation. Future research should focus on practical application. [C778]

"A technique for estimating the detection performance of a skywave over-the-horizon radar"

This paper presents a technique for experimentally estimating the single-look detection performance of a skywave over-the-horizon radar system using observations of a live test target. This technique addresses the challenges imposed by time-varying environmental conditions and multiple propagation paths as well as the presence of multiple unknown targets within the data. We show how estimates of the receiver operating characteristic of the radar system can be derived from estimates of the probability of detection and probability of false alarm and present results for a representative system. [C779]

"The effects of reduced bandwidth on HF surface wave radar performance in ship detection"

Bandwidth reduction not only degrades the range resolution of a radar, but may also reduce the maximum detection range. In the clutter-dominated region, the target signal-to-clutter-plus-interference-and-noise power ratio (SCINR) is reduced by the same factor as the bandwidth, but in the external-interference-and-noise-dominated region, the SCINR is unchanged. A dataset from a monostatic pulse HF surface wave radar (HFSWR) operating between 3 and 5 MHz is used to illustrate the effects of a 3-dB bandwidth reduction on the radar performance. The results show that in the detection of large ships, the maximum detection range is essentially unchanged, but in the detection of small ships, the maximum detection range is reduced. [C780]

"Energy efficient cluster-based target tracking strategy"

This paper proposes a cluster-based target tracking strategy for one moving object using wireless sensor networks. The sensor field is organized in 3 hierarchal levels. 1-bit message is sent when a node detects the target. Otherwise the node stays silent. Since in wireless sensor network nodes have limited computational resources, limited storage resources, and limited battery, the code for predicting the target position should be simple, and fast to execute. The algorithm proposed is simple, fast, and utilizes all available detection data for estimating the location of the target while conserving energy. This has the potential of increasing the network life time. Simulation results show that the strategy saves energy while estimating the location of the target with an acceptable error margin. [C781]

"Target coherence analysis using canonical correlation decomposition for SAS data"

This paper analyzes the connection between the canonical correlations of sonar signals captured using two linear hydrophone arrays and the spatial coherence of the sources that are observed. Analysis of this connection allows for the use of a canonical correlation decomposition (CCD) framework for performing synthetic aperture sonar (SAS)-like processing. In particular, it can be used to extract correlation features of the targets in the frequency domain, which can then be used as a measure for target detection and classification. Results on real and simulated data indicate that coherence patterns are different in the presence of a target when compared to background clutter, and this pattern also changes as a function of the number of sensors on the array. [C782]

"Bi-static and multi-frequency experiments of HFSWR"

High Frequency Surface Wave Radar is currently a well-known surveillance system for the Exclusive Economic Zone. We are still trying to improve their performances and reliability. In this new research step, we are trying to assess the benefits of multi-static as well as multi-frequency configuration. The global ambition is obviously to overcome clutter issue and to increase the coverage for small target. Results presented here highlight the significant contribution of the proposed configuration. [C783]

"Low cost moving target tracking and fire control"

Classical solutions for moving target tracking and fire control are complex and costly as they involve high performance radar, specific weapons and highly accurate seekers. The innovative solution described in this article uses a multiplatform configuration to simultaneously track target and weapon, thanks to a GMTI mode with a wide velocity waveform. The accuracy of the initial designation and the subsequent target+weapon update allow the use of a simpler weapons, drastically reducing the global mission cost. [C784]

"Detecting 3-D rotational motion and extracting target information from the principal component analysis of scatterer range histories"

ISAR imagery of ships are complicated by the 3-D motion of the target, which causes blurring in the imagery. A technique is proposed which could help detect such motion and prove useful to both analyse the 3-D motion as well as possibly help to estimate the 3-D position of scatterers as a by-product of the analysis. The technique is based on principal component analysis of accurate scatterer range histories and is shown only in simulation. Future research should focus on practical application. [C785]

"The optimization algorithm of target range profiling for airborne radar"

The range profile is redundant and disordered because the sample interval time is less than transmitted pulse width. The accurate estimation and optimization of the target range profile are essential for realizing the airborne microwave sensor detection system. In this paper, an algorithm for the real-time estimation and optimization of the target range profile due to over-sampling is presented for the airborne stepped frequency pulse sensor system. Under the condition of oversampling this new algorithm employs the FFT and optimization method to estimate and optimize the target range profile within antenna beam dwell time by using high speed DSP. Through the simulation of sensor data, the target range profile spectrum is measured and analyzed. The result of simulation is that this new algorithm can reduce the effect of over-sampling on the range profile and obtain high resolution range profile of target. [C786]

"Waveform optimal design for MISO space-based radar system"

Based on space-borne multiple-input single-output radar systems, a novel orthogonal bi-phase coding waveform optimization design method is presented. However, it is impossible to design a set of codes with ideal impulsive autocorrelation and idea zero cross-correlation performances. Hence, only the shape of its main-lobe and side-lobe near the detected range cell is considered as the optimization criteria. The aperiodic correlation properties are discussed. Simulation results show that the proposed algorithm is effective and feasible. [C787]

"Most threatening trajectories in a radar coverage area"

In this paper, we will address one key issue for radar load regulation related to dwell priority assignment of Search Domains. Threat Level of search beam position is based on density map of most threatening trajectories (penetration corridors). We studied properties of these trajectories so as to find theoretical results (existence or unicity) and also search algorithm which would be able to compute these trajectories. More particularly, we saw that the classical Г‚Вїshortest path algorithmГ‚Вї get useless when dealing with an additional local geometric constraints (local anisotropy of target Radar Cross Section). We built two sorts of algorithm in order to take this local constraint into account. [C788]

"HFSW radar model and evaluation of a multiscale source extraction approach for target detection"

High Frequency radar, which is based on surface wave propagation, is an important tool to remotely measure sea state. It can also be used to detect targets far beyond the conventional microwave radar coverage. The goal of our project is to investigate this detection capability. In this way, the received power by the system in presence of targets has been modeled leading to a Range-Doppler image. This model can be used for different purpose like, for example, the (theoretical) evaluation of target detection algorithms. In this contribution, a

multiscale source extraction method is also proposed as a detection technique and some first results illustrate its capabilities. [C789]

"The use of SAR-ATI for maritime surveillance and difficult target detection"

This paper discusses the detection of low scatter cross-section maritime targets in a high clutter background using SAR multi-channel along track interferometry. Statistical arguments are presented based on the covariance matrix which enable the determination of the channel weights required to achieve maximum attenuation of false alarms produced by breaking waves. An example is shown of a target (a buoy) with scatter cross-section comparable with the false alarms. A false alarm attenuation of up to 16.1 dB relative to the target is demonstrated for a three-beam interferometer with no a priori knowledge of the target or false alarms. Applications include detection of small stealthy boats and other difficult maritime targets. [C790]

"Analysis and comparison of two disambiguity algorithms: The modified CA and CRT"

In high pulse repetition frequency (PRF) radars ambiguities may arise in range measurements. In this paper we describe and compare two algorithms which can be used even when ambiguous returns from several targets are received. The analyzed algorithms are a modified version of the Clustering Algorithm (CA) and a modified version of the Chinese Remainder Theorem (CRT). The performances of both algorithms have been evaluated in terms of probability of false alarm and probability of detection. [C791]

"Image enhancement and motion compensation of moving targets in ISAR using S-method"

For target recognition applications, a blurred ISAR image has to be refocused quickly so that it can be used for real-time target identification. In this paper, we present the S-method-based approach to real-time motion compensation, image formation and image enhancement of moving targets in ISAR. This approach performs better than the Fourier transform by drastically improving images of fast, maneuvering targets. The method is also computationally simple, requiring only slight modifications to the existing Fourier transform-based algorithm. [C792]

"Optimized algorithms for detection of sparse targets in heterogeneous Gaussian noise"

In this paper we propose two adaptive detection algorithms for sparse targets embedded in heterogeneous AR Gaussian noise. The first one solves the problem of estimating the subset of cells containing a scatterer via the GLRT principle, while the latter models the number of scatterers as a random parameter and relies on the use of quantized statistics. A preliminary performance assessment, conducted by Monte Carlo simulation, has shown that both solutions allow to reduce the detrimental effects, in terms of collapsing loss, suffered by conventional solutions. In particular the former algorithm is to be preferred in terms of performance while the latter has a lower computational complexity. [C793]

"Fast-time STAP for clutter suppression between transmitter and receiver in bistatic radar"

Detection and localization of ground targets in the region between the transmitter and the receiver in bistatic radar is difficult due to strong interference from surface clutter and the direct transmitter signal. We have simulated fast-time (using channels of an array antenna and range bins) and slow-time (antenna channels and radar pulses) STAP (Space Time Adaptive Processing) and find that fast-time gives better interference suppression in this region. We also see that fast-time STAP is useful for all four cases of stationary/moving radar and stationary/moving target and that slow-time STAP with moving radar is useful for both stationary and moving target. [C794]

"A texture analysis of 3D radar images"

In this paper a texture feature coding method to be applied to high-resolution 3D radar images in order to improve target detection is developed. An automatic method for image segmentation based on texture features is proposed. The method has been able to automatically detect weak targets which failed to be detected with intensity based segmentation. [C795]

"Analysis of the KK-distribution with X-band medium grazing angle sea-clutter"

Robust maritime surveillance with radar requires an accurate description of the backscatter from the sea. An estimated probability distribution of the backscatter is commonly used to determine the threshold for separating targets from clutter at a given false alarm rate. Data collected at medium to high grazing angles by the Defence Science Technology Organisation (DSTO) Ingara fully polarimetric X-band radar demonstrates that the

commonly used K-distribution is not always adequate for modelling the probability distribution. This is especially the case for the horizontal polarisation and in regions of high backscatter where target detection can be a problem. An alternative proposed as a more accurate model in this region is known as the KK-distribution. The analysis presented in this paper describes this model with the addition of multiple looks and a thermal noise component to produce greater accuracy in the mean and underlying shape. The threshold required to achieve a constant false alarm rate is then studied and compared with that derived from the K-distribution model. [C796]

"Fast technique for along-track motion estimation of moving targets in SAR images"

A novel fast technique for along-track motion parameter estimation of moving targets detected using SAR mode is presented in the paper. The proposed technique is based on the features of Non Iterative Map-Drift (NIMD) technique. Typically NIMD is used as an autofocus technique in classical SAR processing to obtain high resolution SAR images. The main goal of this paper was to extend and test NIMD as a technique for MTI (Moving Target Indication) motion parameter estimation. [C797]

"The influence of sea surface temperature fronts on radar performance"

A nominal sub-refractive event off the east coast of the United States was modeled with the Coupled Ocean Atmosphere Mesoscale Prediction System. The resulting three dimensional refractivity field was employed as input to the Advanced Refractive Effects Prediction System (AREPS). The sea surface temperature (SST) gradient produced across the western border of the Gulfstream modified the Marine Atmospheric Boundary Layer such that sub-refraction resulted north of the SST front and super-refraction developed south of the SST front. Notional S, C, and X-band radars were modeled by AREPS and detection ranges for a notional target were calculated. Detection ranges were below those for a standard atmosphere north of the SST front but greater than those for a standard atmosphere south of the SST front. [C798]

"Space-time adaptive processing with a half-cylinder faceted conformal antenna"

Conformal antennas, which assumes the shape of the platform, have several advantages, like reduced weight and space; aerodynamic design and increased field of view.We are interested in detection of moving ground targets with air-borne radar with three antenna geometries: faceted or smooth vertical half-cylinder and plane forward-looking. We study important clutter properties for suppressing the clutter with STAP (Space-Time Adaptive Processing) and find that the subarray division is more important than the antenna element positions, that the faceted and smooth antennas give similar clutter properties and that all three geometries have better clutter properties the smaller the subarrays are. The largest tested subarrays are probably useless for clutter suppression. [C799]

"Analysis of bistatic ground clutter characteristics and effects on space-time adaptive processing"

In-depth study of ground clutter characteristics of airborne bistatic radar is significant to clutter suppression and moving target detection (MTD) through space-time adaptive processing (STAP). Based on the geometry configuration that transmitter and receiver align at the same velocity, the paper presents the equation of ellipse on ground and analytic resolution of clutter scatterer location when the two-way distance between receiver and transmitter is constant, derives the clutter ridge expression and gives theoretic explanations to the nonlinear and nonstationary properties of bistatic clutter. Changes of clutter ridge are given under mathematical analysis; meanwhile, STAP performance is briefly analyzed with parameters of platforms at different bounds. Simulations verify the correctness of conclusions given in the paper. [C800]

"Application of MoM-PO hybrid technique in complex target high resolution imaging simulation"

Simulation and modeling of complex targets high resolution imaging by electromagnetic calculating method is very important for high resolution radar targets detection and automatic recognition. In the process of calculating the high resolution image of electrically large targets, high-frequency approximation method and low frequency numerical method have their respective superiorities and limitations, so it is a feasible method to combine the two methods to calculate. In this paper, the high resolution information in wideband frequency of the target with arbitrary shape and in arbitrary attitude is simulated by MoM-PO hybrid techniques for accurate and efficient analysis of scattering fields, and the high resolution range profile (HRRP) and two-dimensional images of the complex target is simulated with these wideband responses. The simulation results show that this hybrid method is effective and applied in high resolution imaging for complex real targets. [C801]

"Time-frequency analysis based image processing for maneuvering target detection in HF OTH radar"

In this paper an algorithm for maneuvering target detection in HF over-the-horizon radar is presented, which is based on the interpretation of the time-frequency map as an image. In the algorithm, radar signal is processed in joint time-frequency domain with short-time Fourier transform. Low-threshold CFAR combined with local thresholding processing transform the time-frequency map into multi-level image. Then neighboring search based region growing technique is developed to extract target ridge among false alarms due to transient events. Real data results show that the presented multi-stage scheme can achieve accurate instantaneous Doppler estimation and good detection performance. [C802]

"An algorithm of angle measurement based on orthogonal dipole antenna"

In order to improve the angle precision of minitype antenna, an algorithm of angle measurement based on orthogonal dipole antenna is introduced in this paper. In this algorithm, target's incidence angle is obtained by measuring the phase error of the left-hand rotation polarization signal and the right-hand rotation polarization signal. Then the method of resolving angle-measuring ambiguity is also presented. Last, the relation of angle measuring precision and involved factors, including SNR, channel amplitude error, and antenna orthogonal error is analyzed. Simulation results indicate that our algorithm can obtain high angle measuring precision, and has good detection capability of omni direction. Besides these, antenna structure is simple, and easy to install and maintain. It has certain engineering application practical value. [C803]

"Structure of robust signal detector for multiple sensors with unkonwn signal-to- clutter ratio"

In practical mutisensor system, the signal-to-clutter ratio of the returns of the same target at different sensors may be unknown and variant, which leads to the nonexistence of the uniformly most powerful test. By investigating the demonstration of the nonexistence, it was found that the canonical detector based on the likelihood ratio test can not possess robust performance of detection. Therefore, a structure of robust detector was proposed that synthesize the results of several canonical detectors to form a robust one. Finally, an example was given to illustrate the effectiveness of the structure. [C804]

"New detection algorithm for range spread target via statistical property diversity"

Based on the statistical property diversity of target and disturbance, a new detection algorithm for range spread target is proposed in this paper. To this end, we first resort to secondary data set to obtain the statistic property of clutter of the cells under test. Then two detectors which focus on calculating the statistical difference of clutter and target plus clutter are designed. Their performance assessment and the comparison with a previously proposed detector show that the proposed detectors can be a viable means to cope with uncertain detection environments. [C805]

"The optimization of window length in target maneuver detection"

D ecision-based approach of target tracking is an important technical field of maneuvering target tracking. In decision-based techniques, detection of maneuver onset is the key factor determining tracking performance. In order to minimize the detection delay of maneuver onset, the window length of maneuver detection was optimized under the Neyman-Pearson criterion. The optimum window length was obtained under various maneuver magnitude. Existence of the optimum window length was verified by computer simulations. The effects of processing interval, probability of false alarm of maneuver detection and maneuver magnitude to the optimum window length were given through computer simulation. In applications, one can consult the simulation results and use priori knowledge such as maneuver magnitude to choose sliding window length so as to get better tracking performance. [C806]

"A novel spacebased SAR cooperation detection method"

A new cooperation detection method is presented to improve the detection performance of the spacebased Synthetic Aperture Radar (SAR) system, which adopts the parallel distributed detection algorithm to process the information acquired by several SARs in one constellation observing the same target area from different angles at the same time. Based on the research of the spacebased SAR system and the distributed detection theory, the Spacebased SAR Cooperation Detection (SSARCD) model is established, which determines the relationship between the detection performance and the parameters of the orbit, the platform and the SAR system. Simulation results prove that the detection performance of the SSARCD system is better than that of the individual spacebased SAR system. [C807]

"An efficient particle filter based distributed track-before-detect algorithm for weak targets"

An efficient particle filter based distributed track-before-detect (PF-DTBD) algorithm is presented in this paper. It

key idea is the fusion of multi-sensor local estimated conditional probability density functions (PDFs). Firstly, the PDFs among sensors nodes are estimated by multivariate kernel density estimation (MKDE) technique based on finite particles set and fused to calculate the fused particle's weight at fusion node. Next, according to Bayes rule, we prove that the unnormalized fused particle' weight is actually composed of sensors' local measurement likelihood, which makes the likelihood ratio test feasible at fusion node. Finally we introduce a detection scheme combining sequential probability ratio test (SPRT) and fixed sample size (FSS) likelihood ratio test to definitely realize TBD process for weak targets. Simulation results show our algorithm is efficient, which reduces delay of detection and improves the precision of state estimation simultaneously. [C808]

"Target detection based on correlation and power features in sea clutter"

In this paper, an adaptive filter is presented for sea clutter suppression that is based upon the real-time median estimation of the power spectrum of sea clutter from the echoes of the detected cells and adjacent secondary resolution cells. The ACSF can suppress most sea clutter in a received time series while retaining possible echoes from a target with small distortion. Two features relevant to the correlation and average power of the filtered time series are proposed for target detection. With the real sea clutter data and simulated target echoes, the experiment results show that the proposed ACSF is effective, and the detector provides better detection performance than some existing methods do. [C809]

"Micro-Doppler analysis of high speed moving targets"

Micro-Doppler induced by mechanical vibrating or rotating of structures in a radar target is potentially useful for target detection, classification and recognition. While the Doppler frequencies induced by the target body scatterers are constants after motion compensation, the micro-Doppler due to vibrating or rotating structures of the target is a function of dwell time. Now the characteristic of micro-Doppler has been used in low speed moving targets' recognition widely, but high speed moving targets have different properties from the low speed moving targets. Due to the influence of high speed, the returned signal after stretch processing will appear range profile broadening and range migration. This paper analyzes the micro-Doppler signature of high speed moving targets, and computer simulations are given to prove the validity of the analysis. [C810]

"Signal fusion network for spatial diversity MIMO radar"

This paper concerns target detection algorithms of spatial diversity MIMO radar. The GLRT algorithm is developed, under the assumption that clutters in different spatial diversity channels follow independent Gaussian distributions with different covariance matrix. The global test statistics turns out to be a production of the local test statistics. Three signal fusion networks are introduced, in which each local site can detect targets with the CFAR property. The CFAR thresholds for the fusion centre and the local sensors can be estimated by offline numerical experiments. It is shown that the signal fusion network yields a better detection performance than that of the decision fusion network. [C811]

"The main practical performance of sparse-array synthetic impulse and aperture radar"

Sparse-array synthetic impulse and aperture radar(SIAR) has large sparse arrays and uses the technology of digital synthetic impulse and aperture of array. It can keep the advantage of traditional meter-wave radar and overcome most of its disadvantage. It is a new kind of advanced digital array radar with synchronously multifunction, low probability of interception, capacity of long-time coherent integration of targets and fine doppler resolution, high feasibility of system processing etc. Here, the SIAR's ability of low-altitude target detection, low probabilities of interception and anti-jamming is researched for sufficiently understanding its main practical performance. [C812]

"A new CFAR method based on test cell statistics"

In this paper, a new Constant False Alarm Rate (CFAR) algorithm, which is called a Modification of the Switching CFAR (SOSGO-CFAR) that takes into account the statistics of samples, is proposed. It employs a composite approach based on the Switching CFAR (S-CFAR) and Ordered statistics with Greatest Option (OSGO-CFAR). Results show that the detection performance of SOSGO-CFAR is similar to that of CA-CFAR in homogeneous background. The ability to control false alarm of the SOSGO-CFAR is close to that of OSGO-CFAR in clutter edges. The detection performance of SOSGO-CFAR is far better than that of S-CFAR in multiple target situations. [C813]

"Adaptive single-tone waveform design for target recognition in Cognitive Radar"

Cognitive Radar is a recently proposed system concept, one of whose most important characteristics is the

closed-loop operation. The feedback structure from the receiver to the transmitter enables the optimization of transmission waveforms based on the latest knowledge about targets and environments. In this paper, we propose an improved waveform design method for target recognition in cognitive radar by restricting the waveforms to be single-tone with constant envelope which are commonly used in practical transmitters. Comparing with a previously proposed method using arbitrary waveforms, our method provides almost the same performance with highly reduced computational cost in sequential transmissions. [C814]

"A M out of n detector based on scattering density"

To improve the detection performance of the binary integrator detector (M out of N detector or M/N detector for short) when the spatial scattering density is sparse, the M out of N detector based on scattering density (BSD-M/N) is proposed. First of all, the average false alarm probability and the average detection probability are obtained. And then, the relationship between the detection performance of the proposed detector and the second threshold M is analyzed for different spatial scattering density and different clutter power levels. Moreover the expression of calculating the optimum M is given. Finally, the experimental results show that the proposed detector outperforms the M/N detector when the spatial scattering density is sparse. [C815]

"Fuzzy fractal algorithm for low-observable target detection within sea clutter"

In this paper fuzzy fractal algorithm for discrete signal processing is introduced. The two major concepts of the algorithm are fuzzy fractal dimension and grade of fractality, which merge fuzzy theory and fractal theory. The fuzzy concept of fractality in discrete time series can be reconstructed as a kind of fuzzy set and the objective short time series can be used by a new membership function. In order to process long time series, sliding measurement is adopted. In the end, the local grade of fractality is applied to X-band real sea clutter and the performance of the detection algorithm is analyzed. [C816]

"A novel detector of range-spread targets"

The detection of the high-resolution radar (HRR) range-spread targets is studied in this paper and a novel method based on strong scattering centers for detecting range-spread targets in Gaussian clutter is proposed. The proposed detector has a two-threshold scheme. First of all, strong scattering centers of target are obtained by setting a first threshold with certain false alarm probability. And then, the detection statistic is formed based on generalized likelihood ratio test (GLRT), which is compared with the second threshold. The experimental results show that the proposed detector is better than the one out of N (1/N) detector, the spatial scattering density-GLRT (SDD-GLRT) detector and the integrator, and also show its robustness. [C817]

"Ground moving targets detection and unambiguous motion parameter estimation based on multi-channel SAR system"

This paper introduces an approach for ground moving targets detection and motion parameter estimation based on multi-channel SAR system which requires three consecutive operations as follows: array calibration, clutter rejection and motion parameter estimation. The analytical expressions of cross-track velocity, along-track velocity, cross-track acceleration and along-track acceleration are derived for multi-channel synthetic aperture radar (SAR) system. On this basis, these motion parameters can be well estimated. Before clutter rejection, array calibration is performed to provide precise parameter estimation latter. Radon transform is used to detect the range walk and correct it. Doppler ambiguity is mitigated by compensating the cross-track velocity estimation. Simulated and real measured data verify the effectiveness of proposed approach. [C818]

"SAR/MMTI: An extension to conventional SAR/GMTI and a combination of SAR and micro-motion techniques"

Synthetic aperture radar (SAR) non-constantly accelerating target detection and imaging is a newly exploited technique. Based on the review of conventional SAR/GMTI (ground moving target indication), we introduce the SAR/MMTI (micro-motion target indication) concept which incorporates micro-motion techniques into SAR. Targets with non- constant radial acceleration are collectively referred to as MMTI targets. The comparison of MMTI, Doppler beam sharpening (DBS), SAR and GMTI indicates that the SAR/MMTI technique features cubic and higher-order phase terms in which phase periodicity may be contained. In what follows, the state of the art in the technique is in detail discussed. Further more, the MMTI related research aspects and methods to be used are recommended. Potential applications of the technique are enumerated in the end. [C819]

"Target detection based on wideband PD radar with linear frequency modulation"

The target detection issue of the PD guidance radar is firstly analyzed in clutter regions under the trail-attack

and low-altitude condition, and then a novel method is proposed, which utilizes new wideband linear frequency modulation system to enhance the target detection performance in clutter region. The signal processing and detection performance are discussed theoretically and calculated for this wideband linear frequency modulation PD seeker radar. The result indicates that the technology of wideband linear frequency modulation can be applied in the PD radar for its improving detection performance in the clutter regions significantly. [C820]

"SAR signatures of moving target"

The synthetic aperture radar (SAR) signatures of moving target are the basis of ground moving target detection and imaging (GMTI&Im). However, previous studies are mainly based on the 2- D separable SAR processing, and little work has been done to investigate the signatures of moving target after the application of a particular fine resolution SAR image formation algorithm. In this paper, we derive the image spectrum of the moving target after two representative fine resolution SAR image formation algorithms, i.e., the range migration algorithm (RMA), and the polar format algorithm (PFA), respectively. Based on the spectrum derived, detailed analysis on the SAR signatures of moving target, including the geometric displacement, residual range migration, and the defocusing effect in both the range and azimuth dimensions are performed. [C821]

"Chaos-based target detection from sea clutter"

The feasibility of applying chaotic features to the maritime target detection is studied in this paper. Experimental results on measured IPIX data shows that embedding dimension, box dimension and correlation dimension, which are not sensitive to the sea state, can reflect the difference between targets and clutter effectively. Such characteristics provide a new idea for further research in obtaining robust maritime target detector. [C822]

"Performance analysis of subband STAP for UWB SAR sparse array"

In order to improve the angular resolution in a UWB SAR system, sparse array is usually used. However, when using UWB SAR sparse array for moving target detection, its wideband introduces challenges such as high-resolution range migration and dispersion, and the sparse array brings angular ambiguity, which causes blind speed and repeated detection. This paper analyzes the performance of Subband STAP for UWB SAR sparse array. The results show it is not only an effective tool to compensate wideband effects, but also can release the angular ambiguity through subband recombination. We also study the performance of the method versus relative bandwidth, which indicates that a four-channel UWB SAR sparse array with relative bandwidth larger than 46.3% can eliminate blind speed and repeated detection totally via Subband STAP. [C823]

"Two dimensional optimal linear detector for slowly fluctuating target"

In this paper, we propose a two dimensional optimal linear detector (2-D OLD) for slowly fluctuating target in Gaussian interference. We assume that the samples of received signal in the range and in the successive pulsation times are collected in a two dimensional array. In conventional detectors, each column of this matrix (the Samples of the same pulsation time) is detected separately and the binary results may be integrated for successive pulsation times in order to improve the detection performance. In fact, by applying binary integration, we ignore the considerable correlation among 2-D data in the azimuth direction. In the proposed 2-D OLD detector, this correlation is considered, aiming to improve the detection performance. Our simulations show that, this detector outperforms conventional one dimensional OLD, as well as the AND and the OR binary integrators. This improvement is more considerable, whenever the clutter samples are more correlated in azimuth direction. [C824]

"WEAK target detection using dynamic programming TBD in CDMA based passive radar"

Long time integration is of great importance in weak target detection in passive radar systems. When an integration time of seconds level is used, a migration of Doppler and range may take place during the process of matched filtering. This paper presents a novel approach named DPA-TBD to obtain target parameters by taking full advantage of the target migration information. DBT and TBD methods are briefly compared in principle. Then a detailed mathematic description of DPA-TBD is introduced. A model of CDMA based passive radar is established with a slow maneuvering moving target. Two methods, CA-CFAR and DPA-TBD, are applied to target detection, revealing that the latter totally overwhelms the former. Finally, simulation results demonstrate the validity of the theoretical analysis. [C825]

"Compressive sensing in radar imaging"

In a conventional radar system, the sampling rate of images is constrained by Nyquist rate. High sampling rate, fast processing speed, and large capacity of memories could be challenges to this radar system. Radar imaging

based on the concept of compressive sensing (CS) is a potential solution. According to CS, sparse or compressible signals can be reconstructed from a small set of their linear measurement. In this paper, we briefly introduce the principle of CS at first. Then we analyse its theoretical scheme in radar imaging and present the numerical simulation results of 1D target detection and 2D radar imaging. This paper concludes with a short discussion and conclusion. [C826]

"Poly-phase encoded waveform optimal design for space-borne MISO radar systems"

The application of multiple input techniques to sparse space-borne radar offers a number of advantages, including mitigating the effect of the target scintillation and being more freedom of signal processing. A novel orthogonal poly-phase encoded waveform optimization design method is presented. It is combined the Genetic Algorithm (GA) with the frequency functions designed by window functions to reduce the computation complexity. For the radar system, multiple transmissions of orthogonal coding signal and single reception, the high ISL of the optimized waveforms may cause degradation of the detection performance of the ground moving target. So, there is a trade-off optimization between the orthogonality and side-lobes of the signals. Simulation results show the effect of the transmission waveforms characteristic on the system's detection performance. [C827]

"Research on detection algorithm of high-speed and low-observable targets"

Both ballistic missiles in midcourse trajectory and space debris have the characteristics of small RCS and high speed, which would be difficult to be detected by the warning radar system. In this paper, based on analyzing the influence of the velocity on high-speed and low-observable target's detection, Keystone Transformation technique is presented to correct the influence of velocity. Finally, according to the system parameters of Cobra Dane radar, simulation is implemented to verify the coherent accumulation based on Keystone Transformation, whose performance is also compared with the coherent accumulation based on Envelope Alignment. [C828]

"A Track-Before-Detect algorithm based on KA-HT"

Track-Before-Detect (TBD) Method has been applied for detecting dim target in low SNR environments. This paper presents a new TBD method based on knowledge-aided Hough transform (KA-HT). Lots of researches which employ Hough transform for target detection focus on the data processing in two dimensional range-time spaces, while the KA-HT method focuses on the three dimensional spaces, which is the range-Doppler-frame space. The whole processing of 3D data space is divided into several parallel processing in 2D data space through Doppler division processing technique. What's more, the method substitutes a point-slope form of HT with some useful prior information for the standard HT, which can avoid the problem of determining the optimum parameter space granularity and algorithm computation is largely reduced due to the use of prior knowledge. In the end, simulations experiments validate the suggested method. [C829]

"IF band width optimization of envelope detection system in presence of phase noise"

In many radar and EW applications, after some processing, the envelope of the received pulse is calculated and is used for target detection. Most of the time only the effect of thermal noise is considered in such detectors, but in most of the practical applications, before envelope detection, the signal should be down converted from radio frequency (RF) to an intermediate frequency (IF). In this case, the phase noise of the local oscillator will affect the signal, too. Surprisingly, in contrast to thermal noise, the effect of phase noise on the envelope of signal becomes more considerable whenever the IF bandwidth is decreased. So there exists an optimum IF bandwidth for the receiver. In signals with higher bandwidths, thermal noise degrades the signal and in signals with lower bandwidths, the phase noise affects it. In this paper the optimum bandwidth is calculated under some realistic approximations. [C830]

"3D image reconstruction of reinforcing bar and pipe using handy microwave radar scanning system"

In this report, an advanced signal processing method for microwave radar is considered to reconstruct a precise 3D image for inner construction in concrete structuresC which consists of reinforcing bars and pipes. An antenna positioning error and an inappropriate signal processing method have caused a degradation of reconstructed images. First, a handy antenna scanning system has been modified, which enables real-time self-position measurement. Concretely, a wheel uplift phenomenon is restrained by stabilizing a compress force to a target surface, and positioning accuracy can be improved. On the image reconstruction result, a superposition of observed data cannot operate well in a region sandwiched by two scanned trajectories. Then, a pipe-shape model is newly introduced, and the 3D object's images have been reconstructed assuming that a continuity of buried object based on it. As a result, buried object's properties can be evaluated more precisely. An effectiveness of a proposed method has been confirmed experimentally, by applying it to a concrete test

specimen and an actual wall. [C831]

"Tracking algorithm inheriting smoothing vector in splitting target tracking"

To track splitting targets using radar measurements, the tracking algorithm is required to maintain the track of the existing target and to initiate a track of new target. In this paper, we propose the track oriented mht (multiple hypothesis tracking) using the smoothing velocity test. In the proposed algorithm, the smoothing velocity vector of existing track is inherited in the new track. Through simulations, we show that the MHT's success rate of both maintaining the existing track and initiating the new track, is 96%. Furthermore, we show that the improved method has an effect of reducing the probability of false track establishment. [C832]

"Asynchronous track algorithm using TDOA/FDOA measurements in the distributed sensor network"

This paper proposes a target tracking algorithm using asynchronous TDOA (Time Difference of Arrival) and FDOA(Frequency Difference of Arrival) measurements for a single target in a distributed sensor network. A conventional algorithm, target localization through TDOA measurements cannot estimate target position when the number of TDOA measurements are not enough for localization at the same time. Thereby, track initialization time is delayed and track accuracy deteriorates in case of that probability of measurements detection for each sensor is low. Our algorithm uses TDOA and FDOA measurements at the different time to compute the position and velocity estimates. Through computer simulation trials, the validity of our algorithm is confirmed. [C833]

"A rapid deployment guided radar sensor"

A need has long existed for a rapid deployment, terrain following security sensor for use around portable resources, along an avenue of approach, or for the temporary replacement of a failed sensor. Existing solutions such as portable microwave or passive infra-red (PIR) sensors are relatively inexpensive, but cannot work over uneven terrain, around corners, or in foliage. The cost and installation complexity of these sensors increases rapidly as more units are required. The RepelsregRF sensor provides many of the required features, but uses sensor cables that are overtly mounted above ground. The OmniTraxregtechnology was first introduced at the 2004 Carnahan Conference, applying ultra wide band radar principles to a ranging leaky cable guided radar sensor. In 2007, a program called TFDIDS (terrain following deployable intrusion detection sensor) was initiated in conjunction with the US Air Force, to apply the advancements in this ranging technology to the rapid deployment sensor needs defined by the USAF tactical automated sensor system (TASS). This advancement includes a novel invention employing the processing of dual parallel leaky sensor cables, termed Stereo OmniTrax. This processing dramatically improves the discrimination between human intrusion threats and small nuisance targets or environmental effects. The TFDIDS system provides a complete lightweight sensor kit for the rapid deployment (less than 30 minutes) of a 100 m detection zone, and later, for the sensor's retrieval and reuse. TFDIDS interfaces to standard Government Furnished Equipment (GFE) including USAF powering and communications devices. This paper outlines the key elements of the TFDIDS design, describes its components, and explains how TFDIDS provides reliable detection using a surface sensor cable deployment. Initial performance results are presented, from tests conducted at the Senstar SITE in 2008. The test applications include through-the-woods, on tarmac and o- n typical open field surfaces. [C834]

"Underwater target detection from multi-platform sonar imagery using multi-channel coherence analysis"

This paper introduces a new target detection method for multiple disparate sonar platforms. The detection method is based upon multi-channel coherence analysis (MCA) framework which allows one to optimally decompose the multichannel data to analyze their linear dependence or coherence. This decomposition then allows one to extract MCA features which can be used to discriminate between two hypotheses, one corresponding to the presence of a target and one without, through the use of the log-likelihood ratio. Test results of the proposed detection system were applied to a data set of underwater side-scan sonar imagery provided by the Naval Surface Warfare Center (NSWC), Panama City. This database contains data from 4 disparate sonar systems, namely one high frequency (HF) sonar and three broadband (BB) sonars coregistered over the same area on the sea floor. Test results illustrate the effectiveness of the proposed multi-platform detection system in terms of probability of detection, false alarm rate, and receiver operating characteristic (ROC) curves. [C835]

"Rare Class Mining: Progress and Prospect"

Rare class problems exist extensively in real-world applications across a wide range of domains. The extreme scarcity of the target class challenges traditional machine learning algorithms focusing on the overall classification accuracy. As a result, purposefully designed techniques are required for effectively solving the rare class mining problem. This paper presents a systematic review of the major representative approaches to rare class mining and related topics and gives a summary of the important research directions. [C836]

"Radar techniques for human gait automatic recognition"

In this paper we extend the investigation on the use of Doppler signatures for human motion detection. As it is well known, human movements generate additional Doppler frequencies on top of the main Doppler carrier. In recent times research has been trying to exploit this effect for dynamic feature extraction and, consequently, automatic target recognition. Here a simulation tool is developed and measurements are presented as a term of comparison. Several scenarios that model arbitrary trajectories and multiple targets are analyzed. Finally we provide an insight into the potential using more than one sensor. This may improve dramatically the performance of the system as it does in many other radar applications. [C837]

"Alignment and illumination issues in scaled THz RCS measurements"

Radar cross section (RCS) measurements are widely employed for the target identification of objects such as aircraft. The RCS of large, complex geometries is usually determined in a well defined, scaled experimental setup. In such a setup, the measuring frequency equates the frequency of interest multiplied by the scaling factor of the model. For high scaling factors, frequencies well above 100 GHz result so that conventional microwave equipment reaches its technological limits. In this paper, we discuss the use of a fiber coupled terahertz time domain spectroscopy system for angle dependent RCS measurements. Several measurements on simple objects like metal plates with corresponding simulations are performed. We also investigate how angular misalignment and displacement of the scatterer effects the measurement results. Moreover, we discuss the influence of non planar incident wavefronts and compare experimentally obtained data to simulations using an enhanced physical optics model. [C838]

"Target's range migration compensation in passive radar"

Ideally the processing gain in passive radar is PG=BT. Where B is the bandwidth and T is the integration time. So by increasing T the target detectability will also increase. But practically, when we deal with moving targets, increasing T will result in a problem: target migration from its range cell that in turn results in decreased processing gain. In this paper we have suggested a method, by which we can compensate target's migration, while keeping the computational load low. [C839]

"Simulation, measurement and validation of amplitude and phase matching performance between transmitter and receiver subsystems in dual-channel high-resolution polarimetric radar"

Stringent requirements for the matching performance between the channels of high-resolution multi-channel radar for superb target detection and classification capabilities have to be met. This paper focuses on the investigation on the amplitude and phase matching performance between two transmitters and two receivers in a dual-channel polarimetric agile radar system. The system will be used to estimate all elements of the polarization-dependent backscattering matrix simultaneously in 3 meters resolution cells. The paper presents breakthroughs in designing such complex radar systems based on very up to date methods used for system level simulations, for measurements and for cross-validation between simulations and measurements. The measurement results of the developed transmitters and receivers demonstrate the validity of our design approach for obtaining the needed matching performance between transmitters and receivers in such a dual-channel radar system. [C840]

"Detection technology for trapped and buried people"

In this contribution we discuss the first results of a running project1, I-LOV, within the German national research program for civil security funded by the German Federal Ministry of Education and Research (BMBF) concerning improved time efficiency and reliable novel detection systems for search and rescue. Classical detection technology covers borescopes and geophones in combination with K-9 units for search and rescue missions in ruins, detritus and cones of debris. An improved and time efficient approach for search of vital signs can be realised with UWB (ultra wide band) radar systems, where a very short wide band pulse is transmitted, or with continuous wave (CW) radar systems for measuring movements like respiration. An improvement of CW with a frequency modulation (FM) leads to FMCW radar systems allowing measuring the distance to targets, i.e. buried people. The search for people carrying electronic RF-devices can be assisted with pulse radar systems. Frequency filters of such devices can be exposed to a radar pulse near the filters' resonance frequency and an

echo can be detected enabling the localization of a device and probably of the owner, too. [C841]

"Feature-Based Probabilistic Data Association (FBPDA) for visual multi-target detection and tracking under occlusions and split and merge effects"

Uncertainties in the sensor data such as measurement noise, false detections caused by clutter, as well as merged, split, incomplete or missed detections due to a sensor malfunction or occlusions (both due to the limited sensor field of view and objects in the scene) make multi-target tracking a very complicated task. Thus one of the big challenges is track management and correct data association between detections and tracks. In this contribution we present an algorithm for visual detection and tracking of multiple extended targets under occlusions and split and merge effects. Unlike most of the state-of-the-art approaches we utilize low-level information integrating it in a unified approach based on a threshold-free probabilistic conception. The introduced scheme makes it possible to utilize information about composition of the measurements gained through tracking of dedicated feature points in the image and resolves data association ambiguities in a soft decision using a globally optimal probabilistic data association approach. Beside existence evolution consideration we also exploit the spatial and temporal relationship between stably tracked points and tracked objects, which along with observability analysis, allows us for reconstruction of compatible measurements and thus correct track update even in cases of splits, merges and partial occlusions of the tracked targets. [C842]

"A meothod for multi-target range and velocity detection in automotive FMCW radar"

FMCW(frequency modulation continuous wave) radar has many useful applications but a serious problems can occur in multi-target situations. Range-velocity processing should suppress so-called ghost targets and detect missing targets presented by beat frequency shift with Doppler frequency. In this paper, a new method is proposed for effective identification of the correct pairs of beat frequencies received from real targets. [C843]

"Advanced occupancy grid techniques for lidar based object detection and tracking"

The robust and reliable detection of objects in the surrounding of a vehicle is an important prerequisite for collision avoidance and collision mitigation systems. In this paper, an ego-motion compensated tracking approach is presented which uses extended occupancy grid methods for both detection and tracking of objects observed by lidar. The approach is able to estimate the velocity and direction of moving objects as well as to distinguish between moving and stationary objects. Additionally, an approach for drastically reducing the computational effort is presented. [C844]

"Multi-target tracking for merged measurements of automotive narrow-band radar sensors"

In this paper, the conventional JPDAM (joint probabilistic data association for merged measurements) algorithm for modelling merged observations, is applied to the automotive environment. As every sensor has limited resolution, the JPDAM should be used instead of the JPDA algorithm, which does not model the effects of measurement merging. As the JPDAM algorithm is more complicated, these effect are normally neglected for most sensors with good resolution capability. In this paper a new automotive prototypical multi-beam monopulse narrow-band FMCW radar sensor is used. While this sensor has good detection accuracy, it has only limited resolution capability. For this sensor, measurement merging leads to wrong target estimations when not modelled correctly in the multi-target tracking process. While the JPDAM algorithm has already been developed for this case, it can not be applied directly, as it does not model the diminished measurement accuracy when more than one measurement is in the same resolution cell. When using a gating procedure with standard measurement accuracy, the merged measurements will not be associated to the corresponding targets. This motivates the usage of a modified gating method which will be presented in this paper. To reduce the computational demands of the algorithm, a clustering technique for the modified gating procedure is shown. The modified algorithm is tested with real sensor data. The JPDA algorithm and the JPDAM algorithm are both applied to a challenging measurement merging scenario and the results of these algorithms are compared. [C845]

"Characterizing Sea Clutter and Detecting Targets via Surrogate Test"

The surrogate test has been extensively employed in testing the nonlinear characteristics of time series. In this paper, surrogate tests are applied to the real-life IPIX radar data to detect targets within sea clutter. Surrogate tests show that sea clutter represents nonlinear tendency while the echoes of small targets show linear tendency. With their different physical properties, the small targets are detected reliably from sea clutter. Comparative experiments show that the proposed method is more accurate and robust than the detrended fluctuation analysis. [C846]

"New search algorithm for randomly located objects: A non-cooperative agent based approach"

In this paper we address the general question of what is the best strategy to search efficiently for randomly located objects (target sites). We propose a new agent based algorithm for searching in an unpredictable environment. The originality of our work consists in applying a non-cooperative strategy, namely the distributed Goore Game model, as opposed to applying the classical collaborative and competitive strategies, or individual strategies. This paper covers only the non-destructive search that occurs when the agent visits the same target many times. The nondestructive search can be performed in either of the two cases: if the target becomes temporarily inactive or if it leaves the area. The proposed algorithm has two versions: one when the agent can move with a step equal to unity and the other when the step of the agent follows a Levy flight distribution. The latter version is inspired by the work of A.M. Reynolds, motivated by biological examples. [C847]

"Control of unmanned aerial vehicles for passive detection and tracking of multiple emitters"

An algorithm for trajectory optimization of autonomous aerial vehicles performing multiple target tracking is proposed. The problem is approached by formulating it as a partially observed Markov decision process (POMDP) and developing a moving-horizon solution taking into account short and long term costs. To evaluate the effectiveness of the approach a simulation involving multiple UAVs and targets is performed. [C848]

"Irradiation Jamming to Inverse Synthetic Aperture Radar"

Based on the transmitting and receiving paths among radar and target and jammer, irradiation jamming method is proposed. Path model and signal model of the irradiation jamming are set up. Then parameters, like the maximum number of ghost targets and the effective jamming to signal ratio, are analyzed. The simulation result shows that many target signals can be detected by radar match filtering and inverse synthetic aperture radar processing in down range profile and 2-D image, including real target, jammer and targets with the same character as the real target. [C849]

"A tri-look detector for single channel SAR-GMTI"

This article studies clutter suppression and detection of moving targets in single channel SAR images. By analysing the most commonly used 3-channel SAR-GMTI principle, a new detector based on tri-look image Cancellation-After-Interferometry (CAI) is proposed where tri-aperture images are constructed by overlapped frequency even-partition of clutter bandwidth. Compared with the single channel SAR detector such as traditional tri-aperture cancellation, simulation results show the proposed algorithm having better robustness against clutter uncertainty especially in strong clutter environments and having capability of detection those with azimuth velocity vector. The simulation and performance comparison with 3-channel detection method also show that the proposed algorithm has no direct capability of parameter estimation resulted from phase randomness in single channel deployment. [C850]

"Research on Tactics Decision of Air-to-Ground Multi-Target Combat"

In the air-to-ground multi-target combat, the target attack order is of great importance to the efficient assignment of weapon resources. In accordance with the characteristics of multiple attribute decision and the threat assessment, a model for assessing targets' threat degree in air-to-ground multi-target attack is established based on the theory of fuzzy multiple attribute decision. The targets' threat degree can be evaluated and obtained with the help of this model. Then the attack decision-making process is studied utilizing the theory of grey associative analysis, based on which a model for air-to-ground multi-target attack decision-making is established. This model transfers the decision-making problem to the solution of the attack value at multi-target, so the target attack sequence can be obtained through solving this model. Finally the target assignment and the attack sequence for multi-aircraft multi-target combat are processed based on the cooperative priority. The availability and effectiveness of this model have been proved by simulation results, providing an effective decision-making method for air-to-ground multi-target combat. [C851]

"Method of Optimal Deployment for Radar Netting Based on Detection Probability"

The optimal deployment for radar netting must treat of many factors that ristrict the capbility of radar network. Traditional decision-making model only considered the maximum detecting range of radar, the conditions used are simple. So, the optimal deployment schemes got by these models are not applicable to modern battle environment.Now, Electronic jamming, Anti-radiation missiles, Stealth targets and the Lowlevel attack of High Speed and High Maneuvering Target have become the "The four major threats" which Radar need be faced with. According to the four countering abilities, this paper establishes the decision-making model based on the detection probablity. And it gives the modeling method using the genetic algorithm. The result indicates that the

modle is efficient. [C852]

"Passive multitarget tracking using transmitters of opportunity"

Passive Coherent Location (PCL), which uses commercial signals (e.g., FM broadcast, digital TV) as illuminators of opportunity, is an emerging technology in air defense systems. The advantages of PCL are low cost, low vulnerability to electronic counter measures, early detection of stealthy targets and low-altitude detection. However, limitations of PCL include lack of control over illuminators, limited observability and poor detection due to low Signal-to-Noise Ratio (SNR). This leads to high clutter with low probability of detection of target of interest. In this paper, multiple target tracking algorithms for PCL systems are analyzed to handle low probability of detection and high nonlinearity in the measurement model due to high measurement error. The converted measurement Kalman filter, unscented Kalman filter and particle filter based PHD filter are implemented and compared for PCL radar systems. The feasibility of using transmitters of opportunity for tracking airborne targets is shown on simulated and real data sets. [C853]

"Statistical MIMO radar under non-Gaussian target scattering"

We consider a multiple-input multiple-output (MIMO) detection problem with M widely-spaced transmit antennas and L widely-spaced receive antennas, and we optimize the signal waveforms transmitted by each source node. Two figures of merit are investigated for space-time code optimization under a semi-definite rank constraint and a received signal-to-clutter ratio constraint: (1) the lower Chernoff bound (LCB) to the detection probability for fixed probability of false alarm, and (2) the mutual information (MI) between the observations and the target scattering matrix. If the scattering distribution possesses some properties of exchangeability and unitary invariance, we show that MI-optimal and LCB-optimal space-time coding admit a simple closed-form solution. As an application, the detection of a compound-Gaussian target is examined. The robustness of code design under Gaussian scattering is also investigated. [C854]

"Fusion of airborne radar and FLIR sensors for runway incursion detection"

Objects on the runway are a leading cause of accidents to landing aircraft. A recent study by RTI for NASA investigated the detection of those objects from the aircraft using sensors commonly found on commercial aircraft: infrared cameras and weather radar. Attention was given to sensor enhancements that would improve the probability of detection, followed by the development of detection routines for each sensor. Finally a fusion process was developed based on a tracking system. A laboratory-based demonstration fusion system has been developed for the detection of runway incursions. This system uses FLIR data recorded from an aircraft on approach including long-wave and short-wave infrared video, aircraft navigation data from NASA flight tests, and simulated radar data based on the flight test parameters. The radar data are obtained from an updated NASA/RTI-developed Airborne Doppler Weather Radar Simulation (ADWRS) program. This paper describes the fusion process and presents initial results of system performance under clear weather night conditions. We show how the FLIR processor effectively extracts targets of opportunity from the infrared imagery. The LWIR provides good target detection capabilities at night when out-the-window visibility is limited to lighted objects. The performance of the fusion algorithm is discussed, showing how it effectively removed false alarms from the FLIR and radar data. The fusion process successfully tracked targets of opportunity and classified them accurately according to the incursion hazard they represented. [C855]

"Analysis and design of multifunction radar task schedulers based on queue"

Inside the set of systems that constitute the avionics, the radar on board is one of the principal systems, both for the commercial and the military aircraft. For a few years ago, the technologies of electronic exploration arrays are used in the radar design, and specially, in the combat fighters, where the detection and tracking of multiple targets is a fundamental requirement. In this type of environments, it is required to use multifunction radar, MFAR (Multi-Function Array Radar), which joins inside the same system, and simultaneously, so much the classic functions of tracking and surveillance, as all the functions related to the communication, countermeasures, calibration, etc. Thus, the functions are implemented according to specific tasks. The principal ones are: surveillance, tracking, confirmation of false alarm, backscanning, reacquisition and communications plane-missile. Therefore, it is required to work with, specialized subsystems inside the radar. They are called task schedulers. The task scheduler is a key element of the radar, since it does the planning and distribution of energy and time resources to be shared and used by all tasks. This paper analyzes the features of the task schedulers based on tasks queues. Radar time is divided in time intervals that are called scheduling intervals. They allow realizing the task scheduling in a flexible and automatic way, planning individually each interval. Therefore, the task scheduler constitutes, for every scheduling interval, the corresponding queue or queues with the tasks planned to execute in that interval. Then, the tasks that are going to execute are selected from those tasks queues. Therefore, the

scheduler includes and applies two scheduling policies: the policy for the constitution of the tasks queues, and the policy of scheduling, which is applied for planning every scheduling interval. Several schedulers have been designed and studied, and it has been made a comparative analysis of different perf- ormed schedulers. The tests and experiments have been done by means of system software simulation. Finally a suitable set of radar characteristics has been selected to evaluate the behavior of the task scheduler working. [C856]

"Discrimination of low-flying vehicle from ground moving targets using multi-path"

The detection of low-flying vehicle by a pulse-Doppler radar is seriously interfered by ground moving targets, for that they have similar Doppler frequency. In multi-path environment, TDOA and DDOA of the low-flying vehicle direct reflection and its multi-path image have some constraint relationship, while this property is not possessed by ground moving target. By taking advantage of this property, a novel approach of discriminating low-flying vehicle from ground moving targets is proposed, which involves the technique of high resolution spectrum estimation. This idea is approved by theoretical analysis and simulation testing, and some applicable system conditions are also discussed. [C857]

"Monopulse characteristic based on full digital weighting for phased array radar at subarray level"

Subarray configuration is usually adopted in phased array radar where monopulse is used to detect the target angle by using sum and difference beam. While analog (Taylor and Bayliss taper) weighting is usually used to suppress the sidelobes of sum and difference beam. This paper presents an approach for phased array radar at subarray level based on full digital weighting at subarray level, therefore it is reduced for the hardware cost and complexity greatly compared to conventional analog weighting at element level, and it takes full advantage of the flexibility of digital processing. Simulation results indicate that the monopulse characteristics obtained by full digital weighting at subarray level quite approximate to that obtained by conventional analog weighting at element level. [C858]

"FM interference suppression for PRC-CW radar based on adaptive STFT"

The influence of FM interference on correlation detection performance of the pseudo random code continuous wave (PRC-CW) radar is analyzed. It is found that the correlation output deteriorates greatly when the FM interference power exceeds the anti-jamming limitation of the radar. A new method is proposed based on adaptive STFT and time-varying filtering for FM interference suppression. The instantaneous phase of interference is firstly estimated utilizing adaptive STFT and the estimated phase error is decreased by means of recursive correcting. A time-varying filter based on the estimated instantaneous phase is set up to excise the interference. The echo signals corrupted by two types of interference including linear FM (LFM) and sinusoidal FM (SFM) forms under different signal-to-jamming ratio (SJR) situations are simulated. It is shown that the method can effectively suppress the FM interference and improve the performance of target detection significantly. [C859]

"RCS calculation of conducting targets in strong random media for E-wave polarization"

This paper discusses the effect of strong random medium on the behaviour of RCS of conducting targets. A comparison with free space case is considered with E-wave incidence. [C860]

"Detection of ships using sub-aperture airborne PolSAR data"

The objective of this paper is to assess the sub-aperture analysis for ship detection using airborne polarimetric SAR data. Three optimal non-normalized coherences can be obtained by tuning the polarization status using the full polarimetric SAR data. These parameters are used to greatly improve the contrast between ships and ocean clutter, since it preserves the intensity and phase information of the coherent target. The airborne polarimetric SAR data is applied to evaluate the results of polarimetric sub-aperture detection for the ships over the ocean. In this way, the improvement in ship detection performance that is realized by using polarimetric information and coherence product is demonstrated in this paper. [C861]

"A fast order method on OS-CFAR detector in SAR images"

Radar fast threshold constant false alarm rate (CFAR) detector, which keeps CFAR by estimating background and adjusting adaptive threshold, is widely used for detecting targets in synthetic aperture radar images. Two typical CFAR detectors based on sliding windows, the cell-averaged CFAR (CA-CFAR) detector and the order-statistics CFAR (OS-CFAR) detector are compared in this paper firstly. The results show the OS-CFAR detector has a better performance at high resolution, but it suffers from the computation burden. This paper proposes a fast algorithm to reduce the computational intensiveness of the OS-CFAR detector and the corresponding

analysis of computational savings are given. According to the experimental results of real SAR data, the experiment result is in good agreement with the theory. [C862]

"A novel double-pulse detection method for aircraft target in ISAR"

Double-pulse or multi-pulse detectors have better performance than single pulse detectors in inverse synthetic aperture radar (ISAR) system. The more echoes we use, the better performance we have if the optimum detectors are utilized. The conventional inter-period correlation processing (IPCP) utilizes the received echoes directly. In this paper, a novel triple stage double-pulse detector is derived. We propose the first stage (nonlinear shrinkage map) to realized noise removal, and the second stage to estimate range migration number. Finally, we utilize the modified IPCP receiver to improve accuracy without the increase of the compute load compared with the conventional IPCP system. The proposed receiver is compared with other conventional detectors based on measured aircraft radar data and achieves satisfied performance. [C863]

"Fractional Fourier transform and its application to SAR imaging of moving targets"

In this paper, we introduce the fractional Fourier transform (FrFT), which is a potent tool for linear frequency modulated (LFM) signal processing, and its applications to synthetic aperture radar (SAR) moving target detection and parameter estimation. A new method based on the FrFT for range cell migration correction (RCMC) is also presented. Both the analytic properties and the advantages are shown. Simulations are finally provided to demonstrate the superiority of this new method. [C864]

"A new approach to range spread target detection based on information entropy"

Based on the diversity between the information entropy of target echo and disturbance introduced by high resolution radar, a new detection algorithm for range spread target via Renyi's entropy is proposed for the first time in this paper. The proposed entropy detector's performance assessment and its comparison with two previously traditional detectors show that the entropy detector can achieve satisfactory performance for the range spread target detection. Remarkably, the proposed entropy detector is not needed to estimate the parameters of clutter environment and is robust to the cells number of range spread target. [C865]

"Novel evaluation method of jamming effect on ISAR based on target detection"

Study on evaluation methods of ISAR jamming effect is to be an important research problem in electronic countermeasures (ECM). Up to now there is no generally accepted progress and objective criterion published. In this paper, on the basis of studying the image model of ISAR point target used the most classical range-Doppler(R-D) algorithm, equivalent jamming-to-signal ratio (EJSR) is utilized, and then the relation between image quality, jamming and jamming effect is built, and the evaluation index via recognition probability of point target is put forward. In the end, aiming to three kinds of typical blanket jamming modes, radio frequency(RF) noise jamming, frequency modulation(FM) jamming and amplitude modulation(AM) jamming, through simulation and analysis, the results indicate the validity and feasibility of the proposed method. [C866]

"Research on application of Keystone transform in radar"

Keystone transform for wideband LFM signal after dechirping is presented in this paper, which can correct range migration and improve the speed of signal processing. The affection of Keystone transform on echoes of ballistic targets with micro-motion and extracting micro-motion information is studied. Simulation experiments are carried out, whose results prove that the algorithm proposed above is valid. Simultaneously, we can draw the conclusion that in order to extract micro-motion or micro-Doppler information Keystone transform should not be applied. [C867]

"The automatic judgment for SAR change detection"

An automatic judgment algorithm based on the autocorrelation coefficient is proposed to solve the problem of targets' arrival or departure after change detection. By building probability distribution model of the polarization vectors in the two SAR images, estimating the autocorrelation coefficient of the current and neighboring sliding window in the extent around change part respectively. Comparing the coherence property, we can distinguish the arrival or departure of the change. Comparing to current algorithm based on the covariance, the algorithm in this paper exploits the autocorrelation coefficient to indicate the coherence property. This algorithm improves the accuracy and robustness of distinguish the arrival or departure. At last, by simulating, we proved the validity of this algorithm. [C868]

"Comparison of several methods for high speed detection target with narrow bandwidth"

A new method dealing with high speed target (HST) detection in pulse-Doppler (PD) radar is proposed. By utilizing Keystone Transform (KT) and linear range walk rectification, the range walk can be removed completely. The method is also compared with the Hough Transform (HT) and Complex Radon Transform (CRT). The simulated data validates the method and the analysis. [C869]

"Road extraction in remote sensing images based on Nonsubsampled Contourlet Transform"

A new method for automated road extraction in remote sensing images is proposed based on Nonsubsampled Contourlet Transform (NSCT). Due to the advantages of multi-scale, multi-direction and translation invariance, NSCT is much efficient for the capture of linear singularity of road target. A pixel-wised feature extraction algorithm is given first based on the analysis of the NSCT coefficient responses for the road target. Final results can be achieved by the simple fuzzy C-means clustering and the postprocessing steps. Experimental results demonstrate that our method outperforms other methods such as Gabor wavelet in accuracy, localization and false detection. [C870]

"Application of assistant knowledge to detect and recognize target in SAR imagery"

Because of the characteristics of its imaging principle, strong speckle and impacted by background clutter, SAR image is very difficult to be interpreted, especially for the complex military targets. An interactive recognition system framework is proposed in this article which using contextual information, geospatial information and multi-temporal images, etc, as assistant knowledge in the recognition workflow. It can help detecting and recognizing some target which is difficult to be detected and recognized through human vision or automatic target recognition technology alone. [C871]

"Array configurations and space-time adaptive processing for spaceborne distributed GMTI radar"

Ground moving target indication (GMTI) is an important, challenging application of space-based distributed aperture radars. Due to the large baseline of the sparse array, the main beam clutter Doppler spread can be reduced and minimum detectable velocity (MDV) can be improved. The cost is the blind zone problem introduced by spatial ambiguities and the grating lobes due to undersampling in spatial frequency domain. This paper investigates some solutions to the blind zone problem of space time adaptive processing (STAP) technique due to grating lobes and spatial ambiguities. In particular, the concepts of Minimum Redundancy Arrays (MARs) and Optimally Irreducible Arrays (OIAs) are introduced to STAP technique for space-based distributed aperture radars in order to solve the blind zone problem. We propose a method by using Optimally Irreducible Arrays combined with waveform diversity to improve the detection performance and present simulation results to show the effectiveness of the method. [C872]

"Performance analysis of long-time coherent integration for moving targets"

Pulse integration technology is widely used to enhance signal-noise-ratio (SNR) for moving ground target detection in Synthetic Aperture Radar and other radars systems. In this paper, the performance of pulse integration of moving targets accounting for target motion errors is analyzed. For the long dwell time condition, the effects of time-variant motion of targets are analytically discussed. The analytical estimation of biased and unbiased compensation residual errors for targets motion is derived. The estimated results show that the biased and unbiased residual errors can lead to significant performance degradation as the dwell time increases. [C873]

"A robust approach to ground moving target detection and localization for multi-channel SAR system"

The strong target contamination has a great influence on the performance of the conventional clutter suppression method. In this paper, a robust approach to clutter suppression and ground moving target detection has been proposed for multi-channel SAR system. Firstly, the modulus normalized vector corresponding to the pixel data vector is constructed and its covariance matrix has been formed. Secondly, the ground clutter is suppressed using the new adaptive clutter suppression weight. Lastly, target detection and localization are carried out. The effectiveness and robustness of the proposed approach are confirmed by performance analysis and real measured data processing. [C874]

"Angle and doppier ambiguity mitigation for spaceborne sparse array GMTI radar"

Ground moving target indication (GMTI) using spaceborne sparse array radar is attractive. To mitigate angle and Doppler ambiguities of the moving target detection for sparse array, the paper presented the model of a multi-

carrier-frequency radar system and analyzed the basic principle of space time adaptive processing (STAP). Finally, the paper presented preliminary simulations to show that the angle and Doppler ambiguities can be effectively reduced by using multi-carrier-frequency technique. [C875]

"Airship radar imaging for stationary and moving targets based on thinned array and code division signal"

In order to reduce the complexity of airship real aperture radar, the stationary scene and moving targets imaging method is proposed based on thinned array and code division signal. It can obtain the phase center that equivalent to the full array, thus avoiding the thinned array high sidelobe and high integrated sidelobe ratio. For the stationary targets, it images directly. For the moving targets, it first adopts traditional MTI to achieve clutter suppression, performs pulse compression and pulse accumulation, and achieves moving targets detection and velocity estimation based on the noncoherent integration of all phase centers data. Then choose the Doppler channel data that the moving target exists in to accomplish moving target imaging. The simulation results indicate the validity of the method proposed in the paper. [C876]

"A novel method of SAR multiple moving targets detection and parameter estimation"

This study proposes a moving targets detection and parameter estimation technique based on short-time fractional Fourier transform (STFRFT) for airborne synthetic aperture radar (SAR). It is able to increase the signal-to-clutter ratio (SCR) and get the Doppler center frequency and Doppler frequency rate for moving targets even they are lying in the same line in the time-frequency plane. At the end, a comparison between the new method and fractional Fourier transform method is provided to illustrate the advantages. [C877]

"An improved ATI method on airborne SAR ground slow moving target detection"

Based on airborne dual channel SAR, this paper improved AT I technique, put forward a weighting factor from DPCA to AT I to improve ground slow velocity moving target detect capability, the method integrated the advantage of DPCA and ATI technique, using the weight value received from DPCA to weighting process the result of interferential ATI, further more, bringing forward a new moving target detect method. The outcome of computer emulation indicates that compared with ATI method, this paper's method can effectively decrease false target number and detect feebleness target efficiency. Compared with DPCA method, it can detect slower moving targets which DPCA cannot detect because of excessive counteraction. [C878]

"Imaging methods for detection of airfield runway disaster"

Ground penetrating radar (GPR) is often used in detecting void and cavities under the airfield runway. Delay and Sum (DAS) imaging method based on time-domain focusing of pulse-echo radar data is commonly applied in imaging technique. Image quality depends on echo amplitude and time delay of backscattered signal that picked up from elementary cell. In this paper, in order to improve the image quality, we decompose the target echoes by calculating the echo amplitude and time delay based on EM inversion theory and then image using DAS focusing method after disposing. The simulation results show that this method improve the image quality greatly. [C879]

"A signal processing method for airborne three-channel SAR-GMTI"

Aiming at airborne three-channel SAR-GMTI system, a signal processing method based on Clutter Suppression Interferometry(CSI) is presented including the processing diagram and the principle of clutter suppression. Channel calibration is proposed to correct the magnitude and phase imbalance between inner channels utilizing the test signal, SAR imaging and clutter cancellation are done successively, finally the accurate target parameters (location and velocity) are obtained. The signal processing approach which has been applied in real data proved its good performance and turned out to be efficient. [C880]

"Local cell-averaging fast CFAR for multi-target detection in high-resolution SAR images"

A local cell-averaging fast CFAR scheme is proposed for multi-target ship detection. The proposed algorithm is based on global censoring scheme to avoid multitarget situation in reference cell. Fast CFAR scheme is employed to reduce computational load. Local average in the vicinity of test cell can remove small sized false alarms so that additional binary clustering is not required for final decision. The test results using real SAR images show good performance in multitarget situation and heterogeneous environment. [C881]

"Doppler ambiguity resolving for SAR ground fast moving target indication"

This paper investigates the restrictions of Synthetic Aperture Radar (SAR) ground fast moving target indication based on the conventional clutter suppression method in image domain which ignores the problems of range cell migration (RCM) and azimuth defocus. A technique for fast moving target indication and motion parameter estimation is proposed based on Doppler ambiguity resolving. In range frequency and compressed azimuth time domain of tri-channel SAR/GMTI data, the clutter is suppressed with DPCA technique, and the Doppler ambiguity number can be estimated from the residual signal using Radon transform. This approach exploits the relation between the line slope and the Doppler ambiguity number of fast moving target. Azimuth focusing is carried out with the criterion of entropy-minimization after azimuth cell migration correction (ACMC), and at last the fast moving target is imaged after range compression. The feasibility of the approach is validated by the real airborne data. [C882]

"A fast algorithm based on two-stage CFAR for detecting ships in SAR images"

Ship detection is an important application of SAR imagery in ocean surveillance. After analyzing the statistical characters of sea clutter, a fast algorithm of ship detection in SAR image is proposed in this paper. The method consists of two CFAR detection stages. The first step utilizes a lognormal based CFAR to sort out the potential target pixels at a high false alarm rate; in the second step, these potential targets are refined under a local process of K distribution based adaptive CFAR detection. Space-born SAR images are used to validate this fast detection algorithm, and results show great improvement on efficiency of the proposed method without decreasing detection performance. The fast algorithm satisfies application demands of ship detection in SAR images. [C883]

"Analysis of phase noise effect on noncooperative wideband bistatic receiver"

Noncooperative narrow-band coherent processing techniques have been developed, however, this capability for wideband signals processing require to investigate further. Of all the obstacles preventing coherent reception techniques from making transition into the optical domain, phase noise caused by system imperfections is one of them. This kind of phase error will defocus discrete scattering centres in the range-Doppler image, which will preclude target identification and analysis. The amount of phase noise in signal is directly related to its so-called bandwidth, the 3 dB line width of its power spectrum. Numerous investigators have studied the effects of laser phase noise. We will examine the effects it has on the performance of this receiver. Both theory and application of this original work is extended in this paper. The research defined a system configuration and assessed its potential performance via modelling. It was developed to support pulse compression of wideband waveforms for applications. The associated implementation issues introduced by electro-optical component characteristics were discussed. Coherent detection was used to implement difference mixing for subsequent digital processing. [C884]

"Coheret integration detection of multiple high speed targets with range migration and Doppler spread"

Range migration and Doppler spread are the two basic and troublesome problems in moving target detection during long integration period. In this paper, a narrowband detection method for multiple high speed targets which effectively solve the two problems above is proposed. The proposed method utilizes keystone transform (KT) to correct range migration, and Doppler spread is compensated according to the target radial acceleration which is accurately estimated by the combination of cyclic auto-correlation detection algorithm and "Dechirping" method, then, coherent integration is implemented for target detection. The new algorithm has many advantages including improved detection performance, an effective solution to range migration and Doppler spread, extended observable coherent integration time (CIT), precise estimation of the target moving parameters and less computation costs. Its performance and computer simulations are analyzed at end of this paper. The simulation results demonstrate the superiority and validity of the proposed algorithm. [C885]

"Multitarget detection and localization method for bistatic MIMO radar"

In this paper, we present a scheme of detection and localization of multiple targets in the same range cell using two transmitters bistatic MIMO radar. The signal model is constructed by means of the rotational factor produced by transmiter. Based on the signal model, canonical correlation test (CCT) method is extended directly to determine the number of targets. Furthermore, a close form solution for localization the multiple targets is presented via ESPRIT. The direction of arrivals (DOAs) and direction of departures (DODs) of the targets can be solved and paired automatically. Simulation results demonstrate the effectiveness of the methods. [C886]

"Signal simulation and research of PMMW radiometer"

The conventional simulation of target detection of PMMW (passive millimeter wave) radiometer assumes that the

detector only has vertical movement. In this paper, based on the mathematical model of target signal of MMW radiometer, we derive the expression of the antenna temperature in the case that the beam centre is not on the axis, and the detector has horizontal and vertical motion. Simulation results are given, and signal characteristics are analyzed. [C887]

"The research and implementation of digital signal processing algorithms on pulse LIDAR"

In order to increase SNR of the echo signal and improve the target detect ability of a pulse ranging LIDAR, researches on digital signal processing technology about the echo signal have been done. Based on digital filtering, pulse accumulation and correlation detection techniques, a signal processing circuit of the laser ranging radar has been designed, using DSP chip. Experimental results showed that digital signal processing technology of the LIDAR, significantly increase the echo SNR, and increase accordingly the maximum ranging distance. [C888]

"Detection of ground slow-moving targets in airborne fire-control radar using adaptive processing"

In the ground slow-moving target detection of airborne fire-control radar, the clutter spectrum varies with range due to the variation of elevation angle and shows high nonhomogeneity. In this case, good detective performance can not be obtained by using conventional method. In this paper, a new method based on "filter-then-adapt" is proposed for single channel airborne radar. The new method can weaken the nonhomogeneity and suppress the clutter returns adaptively. Experimental results with real data illustrate the good detection performance of the proposed algorithm for ground slow-moving target. [C889]

"A signal separation method for phased array radars"

Interferences, clutter and thermal noises greatly influence the target detection by using phased array radars at low signal-to-noise ratio. A blind signal separation based brief and effective signal detection model for phased array radars is brought forward in order to extract the target information Based on the advanced mixing signal model, a method combining the wavelet transform (WT) and independent component analysis (ICA) is proposed. The signal separability of the phased array radars' signals in the clutter and jamming environment is discussed. Simulation results demonstrate that the proposed method is quite effective to extract the target signals and the jamming signals, which is quite practical in the modern war. [C890]

"Detection of ships for OTHR based on AR-MUSIC algorithm"

In order to ensure the data rate, ship detection within short coherent integration time (CIT) is an operational requirement for over-the-horizon radar (OTHR). However, the resulting low Doppler resolution of short CIT brings difficulties in discrimination of the ship target peak and the powerful ocean clutter. To solve this problem, high resolution spectrum estimation techniques have been used to replace the conventional Fast Fourier Transform (FFT) for Doppler spectrum analysis. In this paper, a new spectrum estimation algorithm is proposed for ship detection by OTHR, which has higher Doppler resolution compared with the conventional method. In addition, in case that the signal-to-noise ratio (SNR) is low or the Doppler frequency of the target is close to that of the first-order ocean clutter Bragg peak, the presented algorithm can still effectively be used for ship detection for OTHR. The superiority of the proposed algorithm is illustrated by simulated OTHR data. [C891]

"Clutter processing for digital radars based on FPGA and DSP"

Clutter processing is a key link for vessel traffic services. According to the shortcomings of traditional analog video system, this paper proposes a design solution for digital radar signal processing system based on FPGA and DSP and studies both related preprocessing method and constant false alarm rate algorithm based on wavelet transform. This method can suppress the interference of sea clutter without impairing the target resolution. Experimental results demonstrate this design can decrease the false alarm rate, increase the detection accuracy and improve the tracking performance. Thus, signal processing system based on FPGA and DSP plays an important role in the vessel traffic services. [C892]

"Time Allocation in Cognitive Radar for Multiple Target Detection"

For cognitive radar, it should have the basic function which is learning. The radar needs to manage its resources dynamically and interactively between the setting of radar parameters to optimize the tasks the setting of radar parameters to optimize the tasks to be carried out and perceive environment highlights the role in which knowledge and intelligence will be central in cognitive radar performance. The problem discussed here is the time allocation of cognitive radars in a multitarget environment. Radars are used to detect, to locate and to identify target. In this paper, we develop the optimization criterion based on the detection probabilities. [C893]

"A method for angle estimation using pulse width of target echo"

The time domain characteristic of short range target body echo of UWB array was analyzed based on the Gaussian pulse. The mathematical relation between the pulse width and the most radiation direction of UWB array, angle of target position was put forward, a method for angle estimation using pulse width of target echo was put forward first time. Through simulation and calculating, the feasibility of the new method was validated. [C894]

"Distributed space-based GMTI with synthetic aperture radar"

In this paper, a new target detection and location approach which is performed in three stages is proposed, i.e. array manifold calibration, clutter rejection and target radial velocity estimation. Once the array manifold has been calibrated based on clutter echoes in range-Doppler domain, the objective of clutter cancellation can be achieved by the linear combination of the joint pixels data with the corresponding adaptive weighting vector. This step does not require target steering vector searching. The last stage is carried out at determinate cell under test (CUT) to locate moving target by velocity searching for that one fitting best to the moving target signal, thus the location performance would not be sacrificed in order to suppress clutter and/or interference and the high resolution radial velocity estimation can be achieved. Simulation results demonstrate the effectiveness and robustness of the proposed method. [C895]

"Passive location and precision analysis based on multiple CDMA base stations"

The use of multiple non-co-operative CDMA base stations as external illuminators for passive radar target detection and location is investigated. A signal-processing scheme is developed to locate moving targets. Clutters resulted from direct-path and multi-path signals are filtered adaptively using a well-designed cost function. The target's range and speed information are acquired via pulse compression. Finally by fusing couples of location parameters, the target could be located and the multiple base stations could bring about an improvement in location precision. The real data and simulation results verify the feasibility of this passive location system. [C896]

"A novel method for ship detection in polarimetric SAR images using gopce"

In this paper, a novel method for ship detection in fully polarimetric SAR images is developed. This method employs the Generalized Optimization of Polarimetric Contrast Enhancement (GOPCE) to maximize the target-to-clutter ratio in an image. For comparison, the traditional OPCE, Polarimetric Matched Filter (PMF) and Polarimetric Whitening Filter (PWF) are also used. Experiments results of the NASA/JPL AIRSAR C-Band image over Sydney Coast show that the proposed method has a considerably improvement as to enlarge the separation of ships and sea clutter, demonstrating a robust detection performance. [C897]

"Method for detecting ground moving target with range migration"

For airborne radar detecting ground moving target, the range migration of the moving target was often ignored. However, for the cases of high relative speed between the radar and the target, the range migration should be considered, especially for high range resolution (HRR) airborne radar. Since the range migration can dramatically reduce the performance of detecting the moving target for airborne radar, the effect of range migration must be removed. In this paper, the data model of moving target with range migration is discussed, and a STAP method is proposed for detecting the moving target with range migration. Simulation results show that the proposed method can remove the range migration of all moving targets simultaneously, and improve the detection capability for the ground moving target with range migration. [C898]

"Study on Polarimetric measurement and radar target identification in instantaneous polarization radar system"

Instantaneous polarization radar can obtain radar target polarization scattering matrix (PSM) by taking advantage of single pulse echo signal. The Polarimetric measurement properties and weak target detection of this system is verified by external field experiment. The actual measured data is used to target classification by applying polarization statistical properties and transformation of target polarization scattering matrix or decomposition. Two different radar target identification subject to its polarization properties has been demonstrates the effectiveness of using Polarimetric data and motivates the use of polarimetry for target detection in clutter and interference environment. The back-scattering power and optimized transmission polarization of the system is also involved. [C899]

"A hybrid manmade-target detection algorithm for polarimetric sar images"

This paper proposes a hybrid target detection algorithm for polarimetric Synthetic Aperture Radar (SAR). The proposed algorithm includes three parts: Span Detector (SD), Polarimetric Whitening Filter Detector (PWF) and Optimal Polarimetric Detector (OPD). The detection output of SD is used to optimize the input of PWF, and the detection output of PWF is used to optimize the input of OPD. The iteration is also employed in the proposed method. A new criterion is presented to compare the performances of different polarimetric target detection algorithms. According to the new criterion, different detection algorithms will select the same number of pixels as their detection results. Experimental results demonstrate that the performance of the proposed algorithm is better than other algorithms, and the new criterion is more appropriate for the comparison of different polarimetric target-detection algorithms. [C900]

"Particle filter based approach to road detection in multiband SAR images"

Synthetic aperture radar (SAR) images are widely used for aerial and spatial image applications, such as terrain classification, target detection, etc. SAR images in different bands can provide multi-spectrum information, which is beneficial for more accurate target observation. In this paper, a new method is proposed for joint detection of roads in multiband SAR images. First, the multi-segmented polyline model is introduced to provide a more accurate description of road curve. Then, the roads in SAR images are extracted in a Bayesian tracking framework, and the particle filtering algorithm is employed to implement the tracking. Finally, a joint detection method is proposed to determine the optimal weights of particles based on the maximum likelihood (ML) criterion. The effectiveness of the proposed method is demonstrated by experimental results with real multiband SAR data. [C901]

"An improved TBD method based on modified Hough transform and Viterbi algorithm for early detection of dim target"

Track-Before-Detect (TBD) Method based on Hough transform (HT) has been presented for radar dim target detection in low SNR environments. In view of the flaws of the conventional algorithm based on HT, a new improved method with the optimization principle is proposed based on the modified HT in this paper. The algorithm procedure can be summarized like this: estimating track of target by the modified HT; then fixing a searching region around the track based on dynamic characteristic of target; finally using reduced-complexity Viterbi algorithm (VA) to make non-coherent optimization accumulation of data and detecting target by a set threshold. The experimental results verify the validity and superiority of the proposed approach. [C902]

"Life detection algorithm for stepped-frequency CW Radar"

The micro-vibration activities of the biologic, including heartbeat and respiration, can be detected to identify the life targets, which is widely used in rescue, remote medicine, etc. A new life detection algorithm will be proposed for stepped-frequency continuous wave (SFCW) radar, which mainly based on multi-periods and MTD filter technology to extract the micro-doppler frequency of biologic targets. This algorithm also can get rid of the static objects and estimate the range of the biologic targets. We validate the algorithm by simulation and experimental results. [C903]

"Nonlinear filters for tracking maneuverable ballistic missile targets on reentry"

With the development of the ballistic missile defense penetration technology, the reentry ballistic missile can be maneuverable to change its trajectory in order to achieve defense penetration. Besides the air resistance, the maneuvering force generated by missile causes the abrupt change of acceleration during the reentry duration, so in order to obtain better tracking performance, it's necessary to improve nonlinear filters' adaptability to such maneuver. The paper puts forward a self-adaptive EKF/UKF with attenuation memory maneuver detection based on the conventional EKF /UKF algorithm. When the ballistic missile targets do not change its trajectory on reentry, the filtering precision of UKF is higher than that of EKF, and meanwhile the prior information of the ballistic coefficient can improve the filtering precision and stability. To track the targets which can make trajectory-change for defense penetration, the standard EKF and the standard UKF both have large filtering deviation. However, through maneuver detection and adaptive adjustment of the process noise convariance matrix in time, the self-adaptive EKF/UKF can reduce the filtering error caused by the abrupt acceleration change evidently, and attain a much higher filtering precision and enhanced robustness The simulation results validate this method. [C904]

"Forward scattering micro radars for situation awareness"

In the paper a progress in the netted forward scattering radar research is presented. A special attention is paid

to the optimal and sub-optimal signal processing algorithms. These algorithms are assumed to be efficient when the signal is received at a background of Doppler clutters and AWGN. [C905]

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