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# ТЕМАТИЧЕСКИЙ РЕФЕРАТИВНЫЙ СБОРНИК № 43-2

## “Ultrawideband Radar”
## («Сверхширокополосная радиолокация»)

Публикации в трудах конференций

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### "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. [C1]

### "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. [C2]

### "A multilateral synthetic aperture wireless positioning approach to precise 3D localization of a robot tool center point"

In this paper, a novel multilateral synthetic aperture secondary radar concept and its application for precise 3D localization of a robot tool center point (TCP) are introduced. A backscatter transponder is attached to the TCP of a robot. Spatially distributed FMCW secondary radar units pick up the backscattered phase coherent transponder signals. Based on assisting relative sensors, a synthetic aperture is created with the TCP. The developed multilateral inverse synthetic aperture reconstruction algorithm then determines a probability density function (PDF) of the spatial transponder position. By simulations and experimental results using a 5.8 GHz system with 140 MHz bandwidth it is shown, that 3D localization precision in the mm range can be achieved with the novel wireless local positioning concept even with narrowband radar systems in dense multipath environments. Heretofore, accuracies of this magnitude were only attainable with ultrawideband (UWB) systems utilizing a ten times wider bandwidth. It is shown, that the multilateral synthetic aperture locating system has the potential for a quantum leap in precise 3D wireless local positioning. [C3]

### "A resistive dipole antenna excited by an impulse generator for ultra-wideband radar applications"

For UWB radar applications, a small RD and an impulse generator have been designed and fabricated. The performance of the combined RD and the impulse generator has been proved through the radar scan experiment. The results show that the combined RD and the impulse generator functions well as a UWB radar components. [C4]

### "A practical wireless charging system based on ultra-wideband retro-reflective beamforming"

Numerous portable electronic devices (such as laptops, cell phones, digital cameras, and electric shavers) rely on rechargeable batteries and must be routinely charged by the line power. A wireless charging technique capable of delivering electromagnetic energy to these portable devices would make them tether free and "truly portable." Wireless charging is especially valuable for devices with which wired connections are intractable, e.g.,

unattended radio frequency identification tags and implanted sensors. In recent years, enormous research efforts have been devoted to wireless charging. In 1990s, a case study is reported to construct a point-to-point wireless electricity transmission to a small isolated village called Grand-Bassin in France. In 2007, an inductive resonance coupling scheme, which makes use of near-field coupling between two magnetic resonators, was demonstrated able to power a 60-Watt light bulb over two meters by a team of Massachusetts Institute of Technology. In addition, several companies (PowerCast, WildCharge, WiPower, etc.) have developed products targeting specific applications. Nevertheless, several technical challenges remain to be resolved in order to accomplish practical wireless charging. Specifically, (i) to achieve efficient charging over long distance, severe power loss due to electromagnetic wave propagation must be remedied; (ii) humans' exposure to electromagnetic radiation should always be kept below safety level while sufficient power is delivered to devices; and (iii) some existing systems are unsuitable for ubiquitous deployment due to high cost, large size, and/or heavy weight. In this paper, an innovative wireless charging system based on ultrawideband retro-reflective beamforming is proposed to address the above challenges. The proposed charger consists of multiple antenna elements distributed in space. According to pilot signals (which are short impulses) they receive from the target device, the antenna elements jointly-- construct a focused electromagnetic beam onto the device (i.e., beamforming). Beamforming enables spatially focused/dedicated power delivery to devices while keeping power level in all the other locations minimal. As a result, the proposed system attains high charging efficiency and leads to little hazard/interference to other objects. Performance of the proposed wireless charging system is demonstrated by some simulation results obtained by a full-wave Maxwell's equations solver. [C5]

## "Miniature double-ridged horn antennas composed of solid high-permittivity sintered ceramics for biomedical ultra-wideband radar applications"

Ultra-wideband (UWB) radar sensors are attracting more and more attention, e.g., for biomedical applications. In contrast to established techniques like X-ray tomography or invasive diagnostic approaches, UWB radar offers the potential for remote access and ultra-low power signal intensities. Inspired by promising studies of breast tumor imaging, we are continuing and extending our previous work on biomedical M-sequence radar and antenna techniques. We describe the development and the potential of innovative double-ridged horn antennas, based on high-permittivity sintered ceramics, which have been adapted to the envisaged biomedical applications. In this context, the miniaturization of UWB antennas, due to the restriction to small examination areas, without compromising the electromagnetic fidelity is the overall challenge. For the dielectric scaling of antennas with the potential to operate over wide bandwidths, we focus on nearly frequency independent, high-permittivity and low-loss materials. In what follows, we describe the arduous path from the first idea to functional laboratory versions of double-ridged horn antennas based on solid sintered ceramics. In this way, the paper illustrates the successful interdependence between microwave engineering and mechanical and material engineering. [C6]

## "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. [C7]

## "Noninvasive breast tumor localization based on ultrawideband microwave backscatter"

The key to surgical planning for breast conservation is tumor localization. An accurate localization of the breast tumor is essential to guide the surgeon to the lesion, and ensure its correct and adequate removal with satisfactory excision margins. Current breast tumor localization techniques are invasive and often result in a cosmetic disfigurement. In this paper, we use the ultrawide band radar-based microwave breast imaging technique to non-invasively localize (impalpable) tumors in the breast. We consider four clinically important lesion features: location, size, depth and spatial orientation within the breast. A comparison of the energy of the received signal from healthy and cancerous breasts exhibits some significant differences in some frequency bands. We, therefore, use the energy spectrum of the receiving antenna signal decomposed by wavelet transform as the input to a genetic neural network (GNN) classifier. Furthermore, for improved efficiency, we optimize the structure of the GNN for optimum initial weights and number of hidden nodes. We use CST Microwave Studio to simulate benign and malignant breast conditions, and generate a data set of 1024 cancer cases with various tumor location, size, depth and spatial orientation within the breast. Our results show that the

proposed algorithm gives accurate localization of the breast lesion, and possesses a high sensitivity to small tumor sizes. Additionally, it can accurately detect and classify multiple tumors. [C8]

## "Investigation of the frequency dependent antenna transfer functions and phase center position for modeling off-ground GPR"

We compared different methods to estimate the phase center of an ultra wideband ground penetrating radar (GPR) horn antenna operating off-ground, namely, (1) extrapolation of peak-to-peak reflection values in the time domain and assuming a fixed phase center, and (2), frequency-domain full-waveform inversion assuming a frequency dependent phase center. For that purpose, we performed radar measurements at different heights above a perfect electrical conductor (PEC). A double ridged horn antenna operating in the frequency range 0.8-5.2 GHz was used. In the limits of the antenna geometry, we observed that antenna modeling results were not significantly affected by the position of the phase center, even when considering frequency dependence. This implies that the transfer function model used to model the antenna inherently accounts for the phase center position. This analysis showed that the proposed antenna model avoids the need for the frequency dependent phase center determination and is valid for any applications where the field measured by the antenna can be considered as coming from a distance larger than the antenna aperture itself, such as for off-ground GPR or telecommunications. [C9]

## "An ultrawideband time reversal-based RADAR for microwave-range imaging in cluttered media"

This work presents a new RADAR prototype built for the purpose of imaging targets located in a cluttered environment. The system is capable of performing Phase Conjugation experiments in the ultrawideband [2-4] GHz. In addition, applying the D.O.R.T. method to the inter-element matrix allows us to selectively focus onto targets, hence reducing the clutter contribution. We aim to experimentally explore the use of this focusing wave into an inversion algorithm, in order to improve its robustness against noise. Before testing this idea, we show here the first results validating the prototype separately in the frame of selective focusing via the DORT method and of multistatic-multifrequency inversion. [C10]

## "Performance improvement of pulsed OFDM UWB systems using ATF coding"

In this paper, we examine an enhancement of pulsed Multiband Orthogonal Frequency Division Multiplexing (pulsed MB-OFDM) systems for Synthetic Aperture Radar (SAR) Ultra-Wide Band (UWB) applications. The pulsed MB-OFDM system offers an efficient option for fulfilling the UWB high bandwidth channel requirements. This system combines the two major implementations of UWB, namely the impulse radio and the MB-OFDM, in order to capture the advantages of low hardware complexity and low power consumption in both implementations. A modified half-rate Algebraic Time Frequency (ATF) coding will be used to achieve the proposed enhancement of the pulsed system. This enhancement will result in energy efficiency, i.e. SNR vs. SER, improvement which is particularly useful for SAR systems operating under heavy clutter. Improvements in energy efficiency are tested under different UWB channel models. Simulation results are shown to establish these improvements. [C11]

## "Tapered slot antennas for ground penetrating radar"

The paper presents current results of our ground penetrating radar system design proposed for military application. It is focused especially on antennas, but includes the properties of ultrawideband generator. Several tapered slot antenna structures are presented and some of them have been fabricated. Some modifications of double ridge horn antenna are presented and their parameters are compared and discussed. [C12]

## "Double-sided parallel-strip line-fed circular monopole antenna"

This work presents a double-sided parallel-strip line fed ultra-wideband circular monopole antenna. This antenna exhibits a periodic 2:1 VSWR bandwidth from 1.0-9.0 GHz and a continuous 2:1 VSWR bandwidth from 9.5-14.0 GHz. Above 14.0 GHz, the antenna exhibits a mixture of continuous and periodic 2:1 VSWR bandwidths. At 5.0 GHz the antenna radiates an omni-directional beam with a maximum gain of 5.5 dBi, and at 10.0 GHz the antenna radiates a monopulse beam in the end-fire direction with a maximum gain of 6.7 dBi. These measured results confirm the expected values from simulation. [C13]

## "New Kravchenko transforms and digital UWB signal processing"

In this report the new Kravchenko transforms based on atomic distributions for digital UWB radar signal processing is proposed and proved. This approach have some advantages in comparison with Gabor transform for parameter estimation in radar. [C14]

## "Spectral theory analysis of UWB-oscillations in frequency sinthesizers based on phase-locked loops"

In this report a general theory of phase-locked loop (PLL) for N-dimensional UWB-signals (for example radar and optical signals) is given. On the first step a discretization method for solving differential equations of the PLL systems is presented. It is shown that there are a lot of zones of synchronous in discretized PLL and a technical realization of this device (in PLL with samples). A spectral theory of analysis of oscillations in PLL with samples is given. It is shown a lot of different physical properties in PLL with samples. The effect of shape of the input signals (harmonic signals, splines and atomic functions) at the border zones of operating modes being entered into PLL with samples is examined. [C15]

## "Investigation of phase coded signals based on generalized Frank codes"

In this paper comparative analysis of spectral and correlation characteristics of phase coded signal based on Frank code is given. [C16]

## "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. [C17]

## "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. [C18]

## "UWB radar target sensing and imaging for granular materials research applications"

In this paper, we investigate a first-generation prototype of a radar system that will provide a minimally invasive fully automated measurement of individual and bulk particle movement in a 3D volume. The radar system comprises inexpensive tracer particles as targets, a test signal generation and measurement unit, and a post-processing unit for imaging. The proposed target is a square retroreflector, which is made up of three orthogonal square metal plates. An array of wideband antennas surrounding the testbed is operated in monostatic mode using swept-frequency VNA measurements that are processed to mimic an ultrawideband (UWB) bandpass pulse. In our first-generation prototype, we synthesize a linear array by moving the testbed relative to a single antenna. The testbed contains one or more targets deployed in a free-space (rather than granular material) volume. We perform delay-and-sum beamforming to reconstruct an image of the testbed. Images are generated for the retroreflector at two distinct orientations (normal and oblique) relative to the array. [C19]

## "Radar imaging of a large building based on near-field Xpatch model"

The U.S. Army Research Laboratory's ultra-wideband (UWB) radar was used in field experiments for through-the-wall imaging of an abandoned Army barrack with an approximate 33 m by 27 m footprint. In a previous paper, we used a Physical Optics (PO) based ray tracing code simulating a far-field spotlight configuration in order to explain some scattering features observed in the experimental image (obtained via near-field strip-map configuration). In this paper, we use the same code and model for a data collection geometry that closely matches the experimental setup, and the backprojection algorithm (BPA) for image formation. The new simulated image shows an improved correlation with the measured image, further confirming the applicability of ray tracing codes for UWB imaging in a realistic environment. [C20]

## "Copyright page"

The following topics are dealt with: GPR; radars; communication; medicine; UWB antennas; pulse generation; pulse radiation; electromagnetic compatibility; and electromagnetic metrology. [C21]

## "Ultra-wideband transmitters based on M-sequences for high resolution radar and sensing applications"

In this paper we present a novel ultra-wideband transmitter architecture for high resolution radar and sensing applications up to 30GHz. The concept for pulse compression is based on maximal-length sequences to reduce the peak-to-average power ratio. The proposed transmitter consists of a 29-1 linear feedback shift register (LFSR) to generate the radar signal and a fully differential broadband amplifier. A variable gain control has been implemented to provide high sensitivity and decrease the dynamic range. The presented circuit architecture permits the possibility of upconversion, which drastically increases the operational flexibility of the radar system. [C22]

## "Design alternatives for Foliage Penetration SAR ultra wideband waveforms"

Foliage Penetration SAR has achieved significant operational attention from both military and civilian applications. To achieve the spatial resolution desired, the waveform must occupy fractional bandwidths near 100 percent, and integration angles on the order of π/2. Both design objectives are classified as ultra-wideband, and require special constraints to allow operation in the crowded radio frequency spectrum. This effort examines the SAR waveform design approaches, given the recent advances in digital waveform synthesis, to satisfy frequency allocation constraints. [C23]

## "An approach to suppress RFI in ultrawideband low frequency SAR"

The paper proposes an approach for the Radio Frequency Interference (RFI) suppression in ultrawideband (UWB) low frequency Synthetic Aperture Radar (SAR). The basis of the approach is an Adaptive Line Enhancer (ALE) controlled by the Normalized Least Mean Square (NLMS) algorithm. The proposal is tested successfully on the simulated CARABAS-II data. [C24]

## "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. [C25]

## "Slow-time SAR signal processing for UWB OFDM radar system"

Orthogonal frequency division multiplexing (OFDM) signals, commonly used for a variety of purposes in modern communication systems, are considered from the radar perspective. An experimental system configured as ultrawideband (UWB) software-defined radar (SDR) has been assembled and tested in the synthetic aperture radar (SAR) mode at Miami University. Phase history-necessary for slow-time processing of SAR signals-was previously extracted from a single sub-carrier of OFDM pulses; in this paper we examine a more robust solution of phase history estimation using all subcarriers. The results of the estimation are compared with the ideal single-frequency phase history reconstruction. Simulation examples of cross-range recoveries in noise using both methods are provided and discussed. It is shown that the proposed novel method of slow-time OFDM SAR signal processing is, indeed, a promising technique for multicarrier UWB systems. [C26]

## "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. [C27]

## "A reconfigurable UWB system for real-time through wall imaging applications"

A reconfigurable ultra-wideband system for through wall imaging application has been developed. The radar operating frequency can be selected to cover either 2-4 GHz or 8-10 GHz UWB bands. The lower UWB band is used to minimize through wall attenuation for relatively high loss wall materials, but the upper band can be utilized to achieve high image resolution for relatively low loss walls. A synthetic aperture radar has been developed that utilizes a wideband tapered slot Vivaldi array and covers an ultra wide frequency range, extending over 2-10 GHz; thus covering both regions. The developed beam-forming algorithm is based on near field models, and accounts for wall effects. Both the wave refraction and propagation speed changes are taken into considerations to obtain accurate images of various targets. Real-time experiments have been performed through both dry-walls and brick-walls to validate the performance of the radar system. [C28]

## "Multiport interferometer techniques for innovative transceiver applications"

This paper presents and reviews basic concepts and emerging development of our proposed multi-port interferometer techniques and demonstrates their applications in the design of carrier-based, impulse ultra-wideband and cognitive transceivers at microwave and millimeter-wave frequencies. Such innovative techniques can be extended to the design of transceivers over terahertz and optical ranges. Various architectures of multiport circuits are discussed with respect to different applications. Practical implementations under different technological platforms are described with simulated and measured results for QAM, UWB and tunable multiband applications. In particular, the equivalence between the multiport junction and mixing circuit is highlighted with respect to the concept of interferometers for direct frequency conversion and translation. It is shown that such multiport techniques are very promising and flexible for the low-cost design of integrated microwave, millimeter-wave and photonic systems such as software-defined radio, cognitive radio and radar systems as well as photonic transceivers. [C29]

## "A new method for multipath interference suppression in through-the-wall UWB radar imaging"

When through-the-wall ultra-wideband (UWB) synthetic aperture radar (SAR) is applied to imaging, the interference of multipath spreading between targets will introduce ghosts into the SAR image. This paper proposes a novel technique for through-the-wall UWB SAR imaging with the capability to suppress multipath ghosts. A multipath scattering model is first developed for through-the-wall UWB SAR. By analyzing the model, we obtain an important feature of multipath ghosts in through-the-wall UWB SAR images: aspect dependence. Based on the ghost's aspect dependence, we develop a hidden Markov model (HMM)-based method for suppression the ghosts in the SAR images. Simulations show that the proposed method can improve the peak value ratio of real targets and ghosts by about 15 dB. [C30]

## "Reliability modeling for wireless Ultra Wideband biomedical radar sensing network"

Impulse Radio Ultra Wideband technology is a newly emerged technology suitable for low-power, low-complex, and low-cost biomedical radar sensing network. Fault tolerance and reliability, and power-saving perform a critical role in the operation of the IR-UWB human bio-sensing network designed for real-time human body health monitoring. In this paper, an IR-UWB bio-sensing network is proposed and the continuous Markov process is applied to model the proposed UWB bio-sensor network. Two different models are investigated, one is sensor with three transmitting power levels, and the other is sensor with six power levels. Both of them consume same total amount of power. The radar sensor and the sink node Markov model with repair rates taken into account are modeled as well. The paper is a contributing effort to develop an analytical model and explore the trade-offs in wireless IR-UWB bio-sensor network in terms of predicted reliability, operation time (MTTF), and power consumption. [C31]

## "Suppression of sidelobes and noise in airborne SAR imagery using the Recursive Sidelobe Minimization technique"

The Army Research Laboratory (ARL) has recently developed the Recursive Side-lobe Minimization (RSM) technique (patent pending). The technique is integrated with a standard back-projection algorithm to form synthetic aperture radar (SAR) images with significant reduction in side-lobes and noise. We have achieved significant improvements in noise reduction by applying the RSM technique to our Ultrawideband (UWB) Synchronous Impulse Reconstruction (SIRE) forward-looking radar. This paper presents the application of the RSM technique using data from a side-looking airborne SAR system from SRI International. We describe the RSM technique, the SAR data processing, compare the baseline and RSM SAR images, and quantify the image quality in term of signal-to-noise ratio (SNR) and the statistical distribution of the image pixels to show that significant improvement achieved using the RSM technique. [C32]

## "A design and adjustment method for ultrawideband microstrip antenna design"

This paper presents a combined theoretical and experimental design and adjustment method for ultra-wideband (UWB) microstrip antennas with new geometries on the radiofrequency printed circuit board (PCB) with the permittivity er=2.3 and the thickness h=1mm. The first theoretical design is made by using a standard 3D electromagnetic software package. The antenna specifications are measured and adjusted by the equipment Microwave Test Set IFR 6203B. The obtained antenna has the bandwidth of 600 MHz and very good impedance matching at the resonant frequency 7.2GHz (S11= -55.7dB). This method can reduce time for antenna design in the laboratory conditions. Using it with other initial antenna structures and adding other resonant strips, we can obtain other antennas with smaller dimensions on keeping their large bandwidth and small return loss. [C33]

## "Contrast agent based tumour detection by ultra-wideband radar: A model approach"

For the detection of tumours the application of a contrast agent to visualize the vascularization dynamic is common praxis in numerous imaging modalities, e.g. MRI or biomedical optics. Due to the high vascularization of several types of tumours, its contrast agent concentration exceeds the concentration in neighbouring tissue. Thus, the dielectric properties of the contrast agent will influence the tumour's dielectric properties and therefore the object's reflection coefficient. Furthermore, the vascularization dynamic lies in the time range of minutes. All this encourages us to pursue the detection of tumours by UWB radar, utilizing the change in dielectric properties of the tumour over time by injection of an appropriate contrast agent into the vascular system. [C34]

## "Development of UWB microwave array radar for concealed weapon detection"

This paper describes two approaches to short-range microwave imaging by means of ultra-wideband (UWB) technology. The first approach deals with synthetic aperture radar (SAR) that employs a transmit-receive antenna pair on mechanical scanner. The second one represents a multiple input multiple output (MIMO) antenna array that scans electronically in the horizontal plane and mechanically, installed on the scanner, in the vertical plane. The mechanical scanning in only one direction reduces significantly the measurement time. Two respective prototypes have been built and compared. Both systems comprise the same 10-18 GHz antennas and multichannel video impulse electronics while the same focusing based on Kirchhoff migration is applied to acquired data for radar imaging. The study has been carried out for an application of concealed weapon detection. [C35]

## "Comparison of classical and orthogonal UWB waveforms for radar applications"

In this paper, classical UltraWideband (UWB) waveforms and orthogonal functions (Hermite and Gegenbauer) for radar applications are proposed. The use of this emergent technology in radar applications domains allows the development of compact and low-cost radars with multiple fields of application in daily life. In many classical UWB radar systems, only Gaussian and monocycle pulses are used. UWB waveforms based on orthogonal functions (Hermite and Gegenbauer) are proposed for there good resolution adapted more to radar detection function. There multiple access capacity due to their orthogonality presents an important advantage of these waveforms. This study proposes to compare these waveforms to Gaussian and monocycle pulses with simulations for short range avoidance collision radar application. [C36]

## "Near-field ultra-wideband imaging with two-dimensional sparse MIMO array"

In this paper, we investigate the feasibility of utilizing the concept of effective aperture for designing sparse multiple-input multiple-output (MIMO) array oriented for ultrawideband (UWB) near-field imaging. The array design approach based on the effective aperture concept was previously applied under narrowband far-field conditions. Numerical and experimental studies are performed to show that such method can be still feasible in the near-field of the UWB array aperture. Two-dimensional MIMO array is designed based on the design method with extension using the principle of separable aperture functions. The real 2-D aperture array is compared with its effective aperture measured with synthetic aperture radar (SAR) technique. The similarity of their beam pattern and imaging capabilities confirm the feasibility of the effective aperture approach, and demonstrate the potential of UWB near-field imaging system with 2-D sparse multi-static array configuration. [C37]

## "A sparsity-driven joint image registration and change detection technique for SAR imagery"

This paper presents a novel Sparsity-driven joint Image REgistration and Change Detection (SIRE-CD) technique for SAR imagery. The proposed algorithm simultaneously performs two main tasks: (i) locally register the test and reference images; and (ii) perform the change detection between the two. The key innovative concept here is the sparsity-driven transformation of the signatures from the reference image to match to those

of the test image at the local image patch level. In other words, we are constructing a large dictionary from the reference data and use that to find the sparsest representation that best approximates the new incoming test data. The accuracy level of the approximation determines the detected changes between the reference and the test image. We demonstrate the performance of this technique using both simulated data and real SAR imagery from the Army Research Laboratory ultra-wideband (UWB) SAR forward-looking radar. [C38]

## "Space-time array processing based on ultrawideband throb signal"

Advanced radar and radio communication systems employ space-time array processing to improve performance in terms of detection, resolution, and interference rejection. In this paper, we present the principle of space-time array processing based on ultrawideband (UWB)-throb signal. Analogous to the well known (delay-Doppler) ambiguity function, a space-time resolution (STR) function is derived and analyzed, by computer simulations, for different signal and array parameters, i. e., pulse width, throb rate, array interelement spacing, and number of array sensors. The structure of the STR function is composed of a narrow mainlobe and low-level sidelobes located on the temporal-angular plane. Antenna energy patterns generated from the STR function clearly demonstrate the dependence of angular resolution on the various signal and array-design parameters. The trade-offs between the various design parameters for achieving high-angular resolution as well as high-temporal resolution are attractive in practice. [C39]

## "Clinical trials of a UWB imaging radar for breast cancer"

This contribution presents a selection of phantom and clinical results from a prototype multistatic imaging radar designed and built at Bristol. Complex phantoms are employed in order to approximate the difficulty in imaging breast tissue, however, even so, imaging in a clinical environment poses particular challenges. [C40]

## "Through-the-wall sensing using time-reversal antenna arrays"

In this work, we study the time-reversal antenna arrays for through-the-wall sensing scenarios using ultrawideband electromagnetic waves. Specifically, we show through simulation that the use of differential time-domain signals can be used for localization of the object movement. The differential signals of interest are obtained by comparing the signals received at the time-reversal arrays corresponding to different positions of the moving object. This is particularly helpful in scenarios where secondary scatterers have similar or stronger scattering strengths as compared to that of the moving object. [C41]

## "Scale electrodynamic modeling of ultra wideband systems"

Rules which observance is necessary at performance of scale modeling narrow-band and ultra wideband electrodynamics systems are shown. [C42]

## "Inverse scattering using a Time Reversal RADAR"

This work presents a new RADAR prototype built for the purpose of imaging targets located in a cluttered environment. The system is capable of performing Phase Conjugation experiments in the ultrawideband GHz. In addition, applying the D.O.R.T. method to the inter-element matrix allows us to selectively focus onto targets, hence reducing the clutter contribution. We aim to experimentally explore the use of this focusing wave into an inversion algorithm, in order to improve its robustness against noise. [C43]

## "Performance Analysis of Frequency Sweep Nonlinearities in LFM Radars"

The frequency sweep nonlinearity distortion of LFM signals is one of the most important factors that affect the performance of LFM radars. In this paper, the mathematical models for periodic frequency deviation distortion and non- periodic frequency deviation distortion of LFM signals are made. And the effects of these two types of FM nonlinearity of LFM signals on the matched-filtering pulse-compression performance of LFM radars are investigated profoundly. The computer simulation experiments are performed by using MATLAB language. Also the results are acquired and prove the correctness of preceding theoretical analyses. All the conclusions obtained theoretically and experimentally, provide lots of indispensable theoretical basis and important experiential reference for the linearity correction of LFM signals, the design of wideband (WB) or ultra wideband (UWB) LFM radars, and the performance evaluation and performance optimization of LFM radars. [C44]

## "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. [C45]

## "On benefits and challenges of person localization using ultra-wideband sensors"

This paper gives an overview about advantages and challenges using ultra-wideband sensors for indoor localization of persons including prospects for near-future commercial applications. [C46]

## "Simulated and experimental wavelet-based detection of breast tumor using a UWB radar"

The objective of this work is the detection and localization of breast cancer by means of microwave imaging using Ultra Wide Band (UWB) techniques. The proposed method consists in detecting the time-of-flight signal backscattered by the tumor using continuous wavelet transform. The feasibility of this method is investigated from several simulated and experimental results using a phantom with a UWB pulsed radar. [C47]

## "Synthetic ultra-wideband radar range profile based on stepped frequency pulse trains"

In this paper, stepped frequency pulse trains are utilized to synthesize ultra-wideband radar range profile. Because of the errors of measured target velocity, the synthesized range profile still has range migration and power divergence. Therefore, a new method, called iterative dimidiate approach, is proposed. By exploiting this new technique, the range migration and range spread along range dimension can be neglected. The simulation results prove the validity of the method. [C48]

## "Ultrawideband VHF/UHF dipole array antenna"

A linearly-polarized ultrawideband dipole array antenna has been developed for coverage in the VHF/UHF frequency range for communications or radar applications. The antenna design utilizes a horizontally polarized array of thick tubular dipole elements above a ground plane. Numerical electromagnetic simulations were used to analyze and optimize the antenna parameters prior to fabrication. Measurements of a 24-element ultrawideband dipole array prototype in an anechoic chamber demonstrate the antenna's return loss and gain pattern performance over a wide bandwidth. [C49]

## "Microwave-range imagery with an ultrawideband time reversal-based RADAR"

This work presents a new RADAR prototype built for the purpose of imaging targets located in a cluttered environment. The system is capable of performing Phase Conjugation experiments in the ultrawideband [2-4] GHz. In addition, applying the D.O.R.T. method to the inter-element matrix allows us to selectively focus onto targets, hence reducing the clutter contribution. The system has been validated by physically backpropagating the focusing wave into the medium all over the frequency band and observing the expected focusing properties. [C50]

## "An implementation of step recovery diode-based UWB pulse generator"

Ultra-wideband (UWB) wireless communications and carrierless UWB radar technology use narrow nanosecond or sub-nanosecond pulse as the transmission medium. This paper presents an implementation of sub-nanosecond level pulse generator. The main principle is using the rapid step recovery characteristics of step recovery diode (SRD) to shape the driving pulse, shorten the rise time, narrow the pulse width, then gain the required UWB pulse. The final actual measured pulse width is about 600 ps, amplitude is about 5 V. It is enough for practical applications, but the ringing is a little too big, the amplitude is relatively low. The paper provides a simple method to design UWB pulse generator. Although there is some room for improvement, it has important reference value for the use of SRD in UWB pulse generating in the future. [C51]

## "Preliminary results of a low-frequency 3D-sar approach for glacier volume mapping"

First experimental results with a low-frequency, ultra widebad (UWB) radar for estimating the height of glacier beds are illustrated. We use a 3-dimensional Time-Domain Back-Projection (TDBP) algorithm which incorporates the influence of the refractivity of ice to reconstruct the glacier bed of the Aletsch Glacier in the Swiss Alps using several CARABAS data sets. As the results indicate, the proposed method underlines the ability of low-frequency Synthetic Aperture Radar (SAR) to penetrate into glacier ice and thus, to map glacier volumes on a large scale even with only few, suboptimal data acquisitions. [C52]

## "Atmospheric turbulence effects on radar systems"

The paper discussed the atmospheric turbulence effect such as angle-of-arrival, signal-to-clutter and noise ratio for lognormal clutter and Weibull clutter and detection probability of ultrawideband pulse in radar system. The detection probability is degraded for short pulse and for more turbulence. [C53]

## "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. [C54]

## "Method of reducing antenna RCS using bionics principle"

Bionics principle is applied to antenna radar cross section (RCS) reduction in this paper. Based on a printed circular disc monopole antenna, two novel bionic antennas are proposed by use of two models from animal kingdom and plant kingdom, respectively. Monostatic RCS and ultrawideband related characteristics of the three antennas are simulated, experimentally verified and compared. The results show that compared to the reference antenna, bionic antennas have lower RCS and favorable radiation performances, which demonstrates that the method of applying bionics principle to antenna RCS reduction is valid. [C55]

## "Atmospheric turbulence effects on radar systems"

Atmospheric turbulence has been shown to have measurable effects on several aspects of radar performance. In this paper we discuss the perturbation of the angle-of-arrival (AOA) of radar beams caused by the atmosphere, the effects of lognormal- and Weibull-distributed clutter on detection performance, and the detection probability of ultrawideband pulses propagated through the atmosphere in the presence of turbulence and Gaussian noise. We find that AOA effects are on the order of a few microradians, which is a negligible level for most applications, but that clutter and noise, when combined with turbulent fluctuations, give some surprising results when the ratio of signal to clutter and noise is calculated. The detection of ultrawideband pulses is analogous to the "needle in a haystack" problem. In this paper, we present theories describing each of these phenomena, together with calculated results. For AOA, we have made measurements for one-way propagation that agree well with this theory, but the other phenomena have yet to be measured. [C56]

## "Radar cross section of the human heartbeat and respiration"

This paper describes an experimental approach for finding the radar cross section (RCS) of human heartbeats and respiratory movements. A measurement setup, a calibration routine and required processing steps are presented. Using a 2-3GHz Ultra Wideband (UWB) radar, heartbeats and respiration of a human subject were recorded from a distance of 1.14m. Combining the recorded data to measurements with a calibration sphere, the calibrated human heartbeat and respiration RCS was detected. [C57]

## "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. [C58]

## "Soil dielectric and senisitivity analysis for subsurface imaging applications based on distributed Sensor Networks"

The concept of a subsurface imaging technique based on Unattended Ground Sensor Networks operating in the VHF range using ultra-wideband waveforms was recently proposed in. In this approach a forward model for

realistic subsurface environment based on the Dyadic Green's function for a stratified medium and an inversion technique using an ultra-wideband near-field focusing were presented. Simulation results showed that very good lateral and depth resolution could be achieved. Before carrying out an experiment to test the proposed technique, three vital aspects of the work which are imposed by practical limitations are investigated and presented in this paper. First, the sensitivity analysis to assess the signal penetration depth in realistic subsurface environments for various frequencies is performed. Analysis of the frequency requirements of the inversion as they relate to depth resolution is also analyzed. A semi-analytic soil dielectric model originally devised for microwave frequencies is extended to VHF and validated using measurement results available in literature. [C59]

## "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. [C60]

## "Design and Implementation of a 1.5Gsps Digital Channelized Receiver"

Based on the derivation of the efficient implementation structure of the frequency domain polyphase filter digital channelized receiver, a digital channelized receiver was achieved on the hardware platform with I/Q sampling, 1500Msps, 64channels. In order to ensure good performance of the system, optimization of the processor speed and processor resources was fully considered during the design process of the whole system. The actual ultra-wideband signal test results show that the digital channelized receiver is in good performance. [C61]

## "The usage of extremal coherent integration in the algorithms of processing of reflected sygnals"

The advantages of digital algorithms when processing of radar data are indicated. The directions of coherent combining usage of returned signals in radar systems are shown. The range of new digital algorithms of the movement of air objects estimate parameters (including signals with carrier frequency tuning from impulse to impulse) is described and it is based on the list of degree of taking realizations coherence. The requirement for sound signals parameters, providing single retrieval of information, are determined. [C62]

## "Estimation power and spatial characteristics of ultrawideband radar for statement of protecting handicaps"

Considered the factors that determine the conditions of radiotechnic suppress radiolines control explosive devices, an analysis of experimental studies and an estimate of parameters suppressed radiolines that allows us to determine energetically and spatial characteristics of the antenna system. On the basis of tactical considerations location ultrawideband RTS combat formations moving columns, select a maximal range of producer interference, 20 m and the spectral composition of the signal handicaps of 100 ... 3000 MHz. [C63]

## "Practical application of UWB georadar technique for investigations of cultural heritage objects"

The UWB GPR technique is applied for investigation of covered structure of cultural heritage objects without affect their construction integrity. The obtained information is important for restorers since the most part of it is not available for conventional diagnostic methods and technical documentation is often lost. Some examples of cultural heritage objects investigations are performed. [C64]

## "Estimation of dielectric permittivity of medium by analysis of UWB radiolocation signals from local object"

The method of accuracy enhancement of medium permittivity estimation based on measurements of time delays of UWB signals reflected from local object and received in different points of radar scanning trace is suggested. The mathematical relations have been obtained for estimation of investigated medium permittivity and measurement errors and evaluation of algorithm accuracy gain in comparison with common methods has been made. [C65]

## "Way of an estimation trajectory instability of flight of the air targets"

In article necessity of measurement and the account for systems of construction of radar-tracking images of parameters trajectory instability flight is proved. The method of an estimation of the law of change of angular speed of turn of the air target on sequence range profiles is offered. The estimation of reliability of the received information is made at decrease in the relation a signal/noise. [C66]

## "Influence of the screen on the range properties of rarefied arrays of near-omnidirectional radiators"

The directional characteristics of arrays of isotropic radiators, Hertz dipoles and half-wave dipoles located above the screen at the arbitrary distance were theoretically investigated. To ensure minimum distortion of the form of ultra-wideband pulse signal radiated by the array, it is proposed to use the radiators of various lengths and arrange them at the different distances from the screen. [C67]

## "Sampling duration for noisy signal conversion"

A selection of the working band (sampling duration) of the sampler for optimal recording of noisy videopulse radar signals has been considered in the present work. [C68]

## "The device for remote monitoring of human's heartbeat"

This article describes creating principles of the device intended for round-the-clock human breath and heart rate monitoring. This device can be used in intensive care unit's and burns departments, maternity hospitals and also by EMERCOM employees. Heart rate detection is possible because of the Doppler effect. The Doppler frequency selection is based on the homodyne method of signal conversion. [C69]

## "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. [C70]

## "UWB Baby Monitor"

A successful case for UWB technology application to Vital Signs Monitoring Systems created by authors is presented in this paper. Baby Monitor for remote contactless monitoring of respiratory and heart rate is designed both for consumer and medical infant monitoring applications. Unlike conventional sound- and video-based baby monitors, which do not provide any useful information at infant sleep time (no sounds or static picture) the devices allow permanent parental control and effectively prevent Sudden Infant Death Syndrome (SIDS) from occurring. SIDS is reported to be leading death cause of healthy infants after one month age. [C71]

## "An ultrawideband (UWB) switched-antenna-array radar imaging system"

A low-cost ultrawideband (UWB), 1.926-4.069 GHz, phased array radar system is developed that requires only one exciter and digital receiver that is time-division-multiplexed (TDM) across 8 receive elements and 13 transmit elements, synthesizing a fully populated 2.24 m long (λ/2 element-to-element spacing) linear phased array. A 2.24 m linear phased array with a 3 GHz center frequency would require 44 antenna elements but this system requires only 21 elements and time to acquire bi-static pulses across a subset of element combinations. This radar system beamforms in the near field, where the target scene of interest is located 3-70 m down range. It utilizes digital beamforming, computed using the range migration synthetic aperture radar (SAR) algorithm. The phased array antenna is fed by transmit and receive fan-out switch matrices that are connected to a UWB LFM pulse compressed radar operating in stretch mode. The peak transmit power is 1 mW and the transmitted LFM pulses are long in time duration (2.5-10 ms), requiring the radar to transmit and receive simultaneously. It will be shown through simulation and measurement that the bi-static antenna pairs are nearly equivalent to 44 elements spaced λ/2 across a linear array. This result is due to the fact that the phase center position errors relative to a uniform λ/2 element spacing are negligible. This radar is capable of imaging free-space target scenes made up of objects as small as 15.24 cm tall rods and 3.2 cm tall metal nails at a 0.5 Hz rate. Applications for this radar system include short-range near-real-time imaging of unknown targets through a lossy dielectric slab and radar cross section (RCS) measurements. [C72]

## "Experimental validation of high-permittivity ceramic double-ridged horn antennas for biomedical ultra-wideband diagnostics"

Low-power ultra-wideband (UWB) radar sensors are attracting more and more attention, e.g., for biomedical diagnostics. In contrast to established techniques like X-ray tomography or invasive approaches, UWB radar offers the potential for remote access and, based on suitable waveforms, ultra-low power signal intensities. THis paper presents a complete characterization of a miniature ceramic double-ridged horn antenna. The input matching, radiation pattern, and impulse response reveal a performance promising for biomedical diagnostics. A further improvement and miniaturization will become accessible by optimized manufacturing processes and feed impedance, respectively. Preliminary volunteer measurements showed the suitability of the antennas for the envisaged applications and justify our approach. [C73]

## "An s-band ultrawideband time reversal-based RADAR for imaging in cluttered media"

This work presents a new RADAR prototype built for the purpose of imaging targets located in a cluttered environment. The system is capable of performing Phase Conjugation experiments in the ultrawideband GHz. In addition, applying the D.O.R.T. method to the inter-element matrix allows us to selectively focus onto targets, hence reducing the clutter contribution. The system has been validated by ph-syically backpropagating the focusing wave into the medium all over the frequency band and observing the expected focusing properties. [C74]

## "Real-time through-wall imaging using an ultrawideband multiple-input multiple-output (MIMO) phased array radar system"

A real-time acquisition and processing architecture has been developed for an ultrawideband (UWB) S-band (2-4 GHz) multiple-input multiple-output (MIMO) phased array radar system that facilitates greater than 10 Hz imaging rates, providing a video-like radar image of what is behind a concrete wall. Video rate imaging enhances the interpretability of range vs. range through-wall and free-space radar imagery. Images are formed without a-priori information. Video framerate imaging is achieved by designing an electronically switched bi-static array using high-performance microwave components, a multi-threaded data pipeline, and efficient hardware-accelerated processing algorithms. Experiments successfully image low radar cross section (RCS) objects, fast moving objects in free-space, and a human behind a 10 cm-thick solid concrete wall. [C75]

## "Presentation of the field surface wave generated by an antenna at the interface of two homogeneous media"

In circumstances where the dispersion of the permittivity can be neglected, the tangential component of the surface wave is expressed through the Laplace function of two complex arguments algebraically. This reduces the computation time of the surface wave at a given point to a few milliseconds, and to determine the current in the radiating antenna, as well as the dielectric constant of the underlying surface, for the time of the order of several seconds. Obtain estimates of the surface wave field for the most typical parameters of soils. These calculations can be used to select regularizators inverse GPR for quantitative calculations of the parameters of the soil and for the qualitative interpretation of GPR data. [C76]

## "Search algorithm for local objects in GPR image"

An automatic search algorithm for local objects in GPR profile has been considered in the work. The algorithm is based on the Hough transform. The proper software tool has been developed in order to analyze the accuracy of the permittivity of ground as well as coordinates of the local object in a GPR profile. The algorithm efficiency with simulated data has been shown. The influence of the sampling-step at sounding on the algorithm accuracy has been considered. [C77]

## "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. [C78]

## "Applications (GPR, radars, comunication, medicine)"

{no data available} [C79]

## "Measurement of coordinates of the targets placed behind of radio-transparent barrier with multi-static ultra-wide band radar"

High accuracy measurement of coordinates of the targets placed behind of radio-transparent barrier (inside of closed room) using ultra-wide band (UWB) radar seems to be the perspective field of the investigation. The results of these investigations could be useful when solving problems concerned with combating terrorism, security etc. [C80]

## "24GHz-band UWB-IR pulse generation using optical signal processing"

Experimental demonstration of a 24 GHz-band ultra wideband impulse radio (UWB-IR) pulse generation has been reported. The generated UWB-IR pulse has 24.7 GHz of a center frequency and 9.4 GHz of a -10 dB bandwidth. [C81]

## "Radar and data communication fusion with UWB-OFDM software-defined system"

This paper describes the architecture, testing methodology and experimental results of the software-defined ultra-wideband system built at Miami University. To achieve broadband data communication capability, spectrum-efficient OFDM method of modulation was chosen. The radar functionality using the same OFDM-coded pulses was implemented as well, and tested in short-range experiments. The system operates in X-band with a total transmit bandwidth of 1 GHz. Range resolution of 0.30 meters and data communication capability at approximately 57 Mb/s were established and the system was shown to be able to operate in either mode without any hardware adjustments. This concept may prove extremely useful in high-resolution radar sensor network scenarios. [C82]

## "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. [C83]

## "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. [C84]

## "A simplified modeling of ultrawideband antenna time-domain analysis"

A simplified modeling of time-domain analysis for ultrawideband (UWB) antennas is proposed in this paper. Compared with the conventional model consisted of a pair of antennas, only one antenna is required for the analysis of UWB antenna time-domain characteristics in the proposed model. The same time-domain pulse response can be obtained from the two models, while the overall dimension of the proposed model is only a half of the former one. As a result, the time for simulation can be greatly reduced. The validity of the proposed model is discussed and proved by five typical compact UWB antennas. [C85]

## "Design and application of dielectrically scaled double-ridged horn antennas for biomedical UWB radar applications"

Ultra-wideband sensing begins to play an important role in biomedical diagnostic systems. Promising and

relevant applications include remotely monitored vital functions as well as the characterization of tissues and organs. The acquisition of such physiological signatures requires small and radiation-efficient antennas, designed for ultra-wideband frequency operation. We have developed physically small and adjustable double-ridged horn antennas with which we could demonstrate the specific advantages of miniaturized, dielectrically matched sensor elements in a direct mode compared to remote sensor applications. As a logical consequence of these results, we have considered to replace the lossy high-permittivity liquid by low-loss high-permittivity solid ceramic material to improve the degree of miniaturization and the radiation efficiency further. Some unexpected peculiarities related to this approach are discussed. [C86]

## "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. [C87]

## "A Bayesian approach to respiration rate estimation via pulse-based ultra-wideband signals"

In this paper, theoretical limits on estimation of respiration rates via pulse-based ultra-wideband (UWB) signals are studied in the presence of prior information about respiration related signal parameters. First, a generalized Cramer-Rao lower bound (G-CRLB) expression is derived, and then simplified versions of the bound are obtained for sinusoidal displacement functions. In addition to the derivation of the theoretical limits, a two-step suboptimal estimator based on matched filter (correlation) processing and maximum a posteriori probability (MAP) estimation is proposed. It is shown that the proposed estimator performs very closely to the theoretical limits under certain conditions. Simulation results are presented to investigate the theoretical results. [C88]

## "Compensation of broadband antenna dispersion using optical pulse shaping"

In summary we demonstrate the application of programmable microwave photonic phase filters to compensate a broadband antenna dispersion at a receiver front which enables to increase data rate by overcoming distortion due to antenna nonlinear spectral phase. We also show that dispersion-compensation combined with matched filtering arbitrary waveforms can be used in waveform detection. Our scheme is programmable and broadband and can be used to enhance the performance of ultrawideband wireless systems, in particular satellite communications and radar systems. [C89]

## "Design of a new wire bow-tie antenna for ultrawide-band GPR applications using multi-objective genetic algorithm"

In this paper, a modified resistively loaded wire-bow is designed for impulse ground-penetrating radar applications. The new bow-tie is improved in terms of VSWR and band width. The improvements are achieved by tapering the arms and applying genetic algorithm to choose the optimum parameters for the tapered configuration. Curving arms is designed to decrease the reflection at the drive point, which in turn increases energy radiated to the ground. Genetic algorithm is applied to find the optimum curved antenna parameters. The objective function is composed of broadband performance and VSWR which constitutes a multi-objective optimization problem. The genetic algorithm is used to find, the optimal parameters for the antenna, i.e., resistive loads, loads' locations, number of arms and angular distances between arms. The performance of the proposed antenna is validated in terms of bandwidth and VSWR. Simulation results are presentated to validate the effectiveness of the new antenna as compared with those antennas previously reported in the literatures. [C90]

## "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. [C91]

## "Compressed Sensing for UWB Radar Target Signature Reconstruction"

Ultra-wideband radar target impulse response is characterized by few significant scatterers that can be directly associated with the target geometry such as wing tip, engine inlet, etc. Although there are few scatterers of interest, the UWB nature of the radar sensor requires extensive frequency domain measurements or highly sampled time domain signatures. This requirement is simply a consequence of Nyquist sampling criterion despite the limited number of scatterers along the range (fuselage) of the target. This paper employs the relatively new concept of "compressed sensing" for generating an UWB target signature with as little measurements as possible. The paper applies the concept of compressed sensing to synthetic target models then extends the same approach to real radar signatures recorded in a compact range environment. The results indicate the feasibility of reducing the number of samples needed to accurately characterize and identify target scattering centers. [C92]

## "On the use & application of precursor waveforms"

The use and application of precursor waveforms in dispersive attenuative media is presented, with particular attention given to ultrawideband (UWB) and impulse radar. [C93]

## "Ultra-wideband antennas for combined magnetic resonance imaging and UWB radar applications"

Magnetic resonance imaging (MRI) is one of the most highly appreciated medical diagnostic techniques worldwide. Recent developments aim at adding the capability of creating focused images of moving objects. Among the potential navigator techniques required for such an improved MRI is ultra-wideband (UWB) radar. We have studied the performance of UWB antennas for biomedical imaging inside the 3-Tesla MRI system at PTB Berlin. The strong static and time variant magnetic fields give rise to severe mechanical and electrical interactions due to the induced electromagnetic forces. On the other side, the high magnetic field homogeneity required for MR scans can also be affected adversely by the presence of the UWB antennas. The requirements resulting for the design of MRI compatible antennas have been identified and implemented in terms of a novel type of double-ridged horn antenna. We describe the design of the antenna and its performance for magnetic resonance imaging. [C94]

## "Ultra light-weight antenna system for full polarimetric GPR applications"

The motivation to develop an ultra light-weight antenna system was driven by a space borne radar application. The experiment Г‚Вїwater ice and subsurface deposit observations on MarsГ‚Вї (WISDOM) is a ground penetrating radar (GPR) selected to be part of the Pasteur payload on board the rover of the ExoMars mission. Among the Pasteur panoramic instruments on the ExoMars rover, only WISDOM can provide a view of the subsurface structure. WISDOM is the first GPR on a planetary rover. It has been designed to characterize the shallow subsurface structure of Mars. WISDOM will for the first time give access to the geological structure, electromagnetic nature, and, possibly, hydrological state of the shallow subsurface by retrieving the layering and properties of the buried reflectors. It will address important scientific questions regarding the planet's present state and past evolution. The measured data will also be used to determine the most promising locations to obtain underground samples with the drilling system mounted on board the rover. The instrument's objective is to get high-resolution measurements down to 2 m depth in the Martian crust. The radar is a gated step frequency system covering a frequency range from 500 MHz to 3 GHz. The radar is fully polarimetric and makes use of an ultra wideband antenna system based on Vivaldi antenna elements. The paper describes antenna requirements to fulfil for this very specific GPR application and it gives an overview about the light-weight design and its realization. Simulated and measured antenna performance is compared in this paper. Test measurements were performed in permafrost regions on earth. [C95]

## "A CMOS ultra-wideband impulse generator for 22-29 GHz automotive radar application"

This paper presents the design and simulation of a CMOS ultra-wideband pulse generator using IBM 90 nm CMOS technology. The operating frequency band of the pulse generator is from 22 to 29 GHz for the application of short-range automotive radar. The pulse generator has a simple architecture using digital circuits. The simulation results show that the power spectral density of the pulse generator has a center frequency of 24.4 GHz and has a -10 dB bandwidth from 22 to 29 GHz. [C96]

## "Characterization of tapered-slot antenna designs for subsurface radar applications"

Some characteristics of ultra-wideband tapered-slot antennas important in subsurface radar applications such as

return loss, radiation pattern and low variation of the antenna response with respect to variations of the distance between the antenna and reflecting surface have been analyzed. Three types of the antenna opening, namely exponential Vivaldi type, elliptical flare with corrugated edges and elliptical flare have been studied. All the antennas had been fed by baluns formed of microstrip and slotline radial stubs. [C97]

## "Design of T/R-module for the ultra-wide-band multi-function AESA"

In this paper, the high performance, ultra-wide-band T/R-module, the core sub-system of multi-function AESA for modern military platforms which are required to meet electronic warfare, information warfare, communication, SAR, ISAR, and other radar requirements, has been developed. The T/R module operate over upper C, X, and Ku bands. The T/R module has noise figure of less than 5.1 dB and output power over 36 dBm. Use of LTCC, MMIC and ASIC reducing the overall size and weight. [C98]

## "Synthetic bandwidth method for SAR in deramp-on-receive mode"

As current airborne SAR systems aiming to produce SAR imagery at resolution less than 0.1 m, attaining ultrawideband signal become a difficult problem. Synthetic bandwidth based on frequency-stepped chirps is an available method to achieve this type of ultra-wideband signal, the advantage of which is the reduction of the instantaneous bandwidth and sampling rate requirements of the radar system. This paper analyzed the synthetic bandwidth method for deramp-on-receive signal in detail. To evaluate the capability of this method, simulations were carried out. For the lack of real deramped frequency-stepped chirps SAR data, we proposed an approach to transform the common non-deramped total bandwidth SAR data to deramped frequency-stepped chirps data, then process the transformed data with synthetic bandwidth method, and the imaging results show the validity of the proposed method. [C99]

## "A comparison of data-independent microwave beamforming algorithms for the early detection of breast cancer"

Ultrawideband (UWB) radar is one of the most promising alternatives to X-ray mammography as an imaging modality for the early detection of breast cancer. Several beamforming algorithms have been developed which exploit the dielectric contrast between normal and cancerous tissue at microwave frequencies in order to detect tumors. Dielectric heterogeneity within the breast greatly effects the ability of a beamformer to detect very small tumors, therefore the design of an effective beamformer for this application represents a significant challenge. This paper analyzes and compares 3 data-independent beamforming algorithms, testing each system on an anatomically correct, MRI derived breast model which incorporates recently-published data on dielectric properties. [C100]

## "A novel FM-UWB system for vital sign monitoring and its comparison with IR-UWB"

In the current scenario, where it is becoming very important for many Health Care Monitoring System to provide non-invasive and non-contact measurements, this paper presents a novel monitoring system for vital signs based on the Frequency Modulated-Ultra Wide Band (FM-UWB) technology. First of all, an analysis of the error introduced by each block of the transceiver device is performed in order to better understand the achievable resolution under no ideal working conditions. Then, a comparison with an IR-UWB monitoring system is performed in terms of sensitivity. As it is expected, the FM-UWB radar, which is a continuous wave radar, can achieve the same resolution also working much lower SNRs than IR-UWB systems. This means that proposed system can work also with lower power levels than an IR-UWB device. Moreover, our simulation confirms that the FM-UWB system can achieve the desired resolution (of the order of mm) for the context of interest (heart-beat, respiration rate monitoring). [C101]

## "Bistatic experiment with the UWB-CARABAS sensor-First results and prospects of future applications"

Bistatic SAR experiments are in focus in recent years. We will present first results of an airborne bistatic experiment conducted 2007 in Switzerland with the Swedish ultrawideband sensor CARABAS, operating at 28-73 MHz (UWB). The acquired bistatic data include HH and HV polarization with different bistatic elevation angles, various transmitting flight tracks-including non-linear tracks-and fixed receiving antennas (horizontal and vertical) installed on a mountain top. We will place an emphasis on the processing, improving and evaluating of the data and give an overview of future applications which are made feasible by this bistatic dataset. [C102]

## "FMCW ultra-wideband radar for through-the- wall detection of human beings"

An FMCW ultra-wideband radar concept for through-the-wall detection of human beings is presented.

Propagation modeling through different types of walls and radar cross section measurements of human beings are given. Power budget and dynamic range are computed and discussed for different situations. The realized UWB FM-CW radar is presented and some fast trials of human beings tracking are shown. This radar system will enable large stand-off distance capabilities. [C103]

## "4-bit, 16 GS/s ADC with new parallel reference network"

This paper presents a high-speed 4 bit full-flash analog-to-digital converter with a new parallel reference network for an UWB radar. The ADC is implemented in 190 GHz SiGe BiCMOS technology, has more than 6 GHz effective resolution input bandwidth and operates up to 16 GSample/s. Power dissipation is 1.15 W including test buffers and 750 mW of the converter itself. [C104]

## "Capacity & performance issues in a MIMO based MB-OFDM ultrawide band communication system"

Ultra wideband (UWB) technology is one of the promising solutions for future short-range communication which has recently received a great attention by many researchers. However, interest in UWB devices prior to 2001 was primarily limited to radar systems, mainly for military applications, due to bandwidth resources becoming increasingly scarce and also its interference with other commutation networks. This research work provides performance analysis of multiband orthogonal frequency division multiplexing (MB-OFDM) UWB MIMO system in the presence of binary phase-shift keying time-hopping (BPSK-TH) UWB or BPSK-DS UWB interfering transmissions under Nakagami-m and log- normal fading channels employing various modulation schemes using MATLAB simulations. Also, provides capacity analysis showing variation of channel capacity with respect to distance well as signal-to-noise ratio. [C105]

## "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. [C106]

## "On apodization techniques for ultra-wideband SAR imaging"

Ultra-wideband (UWB) SAR imaging suffers from a number of inherent problems in which the apodization has not been investigated appropriately. This paper presents a discussion on apodization techniques and possibilities to apply these techniques to UWB SAR imaging. [C107]

## "Sub-nanosecond pulse generator for through-the-wall radar application"

This paper presents a sub-nanosecond pulse generator intended for a transmitter of through-the-wall surveillance radar. The basis of the generator is a step recovery diode, which is used to sharpen the slow rise time edge of an input driving waveform. A unique pulse shaping technique is then applied to form an ultra-wideband Gaussian pulse. A simple transistor switching circuit was used to drive this Gaussian pulser, which transforms a TTL trigger signal to a driving pulse with the timing and amplitude parameters required by the step recovery diode. The maximum pulse repetition frequency of the generator is 20 MHz. High amplitude pulses are advantageous for obtaining a good radar range, especially when penetrating thick lossy walls. In order to increase the output power of the transmitter, the outputs of two identical generators were connected in parallel. The measurement results are presented, which show waveforms of the generated Gaussian pulses approximately 180 ps in width and over 32 V in amplitude. [C108]

## "Reconstruction of physiological signatures from synthetic biomedical ultra-wideband signals"

To understand the reflection signals generated by probing the human thorax with an ultra-wideband radar, an analytical model is derived. This model considers ideal antennas and propagation in a closely approximated

stratified arrangement of the thorax. It also accounts for the dispersive behavior of the dielectric properties of the different biological tissues. To model physiological processes intra-thoracic layer variations mimicking myocardial deformation and respiration are mimicked. The reconstruction of these displacements are compared with reference signals for the ideal case. By incorporation of measured antenna transfer functions an approximation towards real conditions was investigated. [C109]

## "An extremely compact dielectric resonator antenna for space-limited UWB wireless communication devices"

An extremely compact ultrawideband (UWB) dielectric resonator antenna is presented for potential use in compact UWB wireless communication devices. The antenna consists of a dielectric resonator of relatively high permitted attached to a thin dielectric segment of relatively low permittivity, positioned on a ground plane. The current version is fed by a coaxial probe although other feeding methods are possible. The use of two dielectrics and multiple resonance modes have helped this design to cover the entire FCC UWB band (3.1-10.6 GHz, 1:3.4 or 109.5% bandwidth) in a very small volume. The antenna size has been further reduced, without compromising the bandwidth, by removing about half of the dielectric volume and applying a metal coating on one side of the dielectrics. [C110]

## "Ultra-wideband testbed for 6.0-8.5 GHz ranging and low data rate communication"

In this paper we present ULANDreg testbed that consists of two European mask compliant impulse radio ultra-wideband (IR-UWB) transceivers with low data rate and medium range for data communication and distance measurement. The transmitter uses time hopping spread spectrum codes to reduce the peak to average ratio in the power spectral density and the receiver is based on a filter bank. The hardware/software partitioning of the receiver provides the testbed with the necessary flexibility. Therefore new ranging algorithms can be tested quickly in real time in order to improve the distance measurements. The ranging protocol performs the distance calculation with four-way exchange of the frame even when there is not a common timing reference between transceivers. The algorithms demodulate data and estimate relative time of arrival (RTOA) in a line of sight (LOS) and non-LOS (NLOS) framework. Finally, distance measurement results are presented showing the functionality of the testbed. [C111]

## "Copula based detection algorithm for MIMO ultrawideband noise radars"

In this paper statistical approach to synthesize algorithms for digital signal processing in UWB noise radar and sodar is used. Nonparametric copula based detection algorithms are suggested. Multiple input multiple output case is investigated. Monte-Carlo simulation for suggested algorithm is done. Experimental check is done on the basis of developed acoustic physical model which is used to build a noise sodar prototype. Developed algorithms can be used in noise radars for different applications. The use of the UWB noise signal provides a very high resolution both in speed and range. [C112]

## "LTCC-based ultra-wideband Linearly Tapered Slot Antenna design guidelines"

In this paper, the design of antipodal non-planar linearly tapered slot antenna (LTSA) designed in LTCC technology with wide bandwidth operation for ultra-wideband applications and a practical design guideline of LTCC-based ultra wideband LTSA is presented. The LTCC-based ultra wideband LTSA characteristics are investigated and then compared to a compact antipodal LTCC-based Vivaldi design. Using microstrip feeding technique, the antenna return loss S11 stays below -10 dB from 9 GHz to 10.5 GHz. From simulation results, the LTCC-based ultra wideband LTSA design, optimized using HFSS, it is found that the LTCC-based LTSA antenna has a broad bandwidth of about 1.5 GHz which satisfies the ultra-wideband bandwidth requirement. The LTCC-based ultra wideband LTSA has an efficient end fire radiation pattern of more than 5 dB peak gain and a total chip area of 50times25 mm2. Therefore this antenna can be used for a variety of ultra-wide band applications. [C113]

## "Monostatic imaging of small objects in UWB sensor networks"

This article introduces new imaging algorithm suitable for the application in UWB sensor networks. This new algorithm outperforms UWB migration imaging algorithms known from e.g. ground penetrating radar, or through-wall applications. Proposed algorithm produces images of an inspected environment that contain fewer artifacts and are easier to interpret. This is illustrated by a measurement example. [C114]

## "Maritime UWB forward scattering radar network: Initial study"

A scenario for an ultra-wideband (UWB) forward scattering radar (FSR) network for detection of low radar cross

section (RCS) maritime surface targets is suggested. A chain of buoys equipped with transceivers which forms a FSR for target detection is considered. In this paper, the first stage of the study is described and major aspects of future work are discussed. It was shown that the high level of surface clutters related to FSR might be reduced by utilisation of UWB technology. As a preliminary further investigation, a numerical simulation of the 3-D RCS for comprehensive models of small maritime targets is obtained and comparisons with simplified target models are made. [C115]

## "Optimum two-pulse UWB detector for different target fluctuation models"

Single pulse UWB detectors do not have good performance as two-pulse or multi-pulse detectors. The more signals we use the better performance we have if we use optimum detectors. In this paper, we derive two-pulse optimum detectors for different target fluctuation models and extend them to multiple pulses. In each section of fluctuation model, suboptimum detectors are proposed to have good performance for targets with different number of bright points. [C116]

## "Influence of multipath propagation on UWB imagery"

In this paper the influence of multipath propagation on the quality of UWB imagery is analyzed. Typical UWB imaging methods like time domain migration consider only propagation paths with one reflection at the object of interest. In most scenarios the paths of higher order are attenuated sufficiently to neglect them. However, in scenarios containing metallic objects (e.g indoor factory scenarios) multiple reflections can occur without strong attenuation of the signal. In this paper the influence of these multiple reflections on the generated image is investigated. [C117]

## "Physiological signatures monitored by ultra-wideband-radar validated by magnetic resonance imaging"

To validate physiological signatures acquired by ultra-wideband (UWB)-radar, like breathing and cardiac deformation, we propose the comparison with simultaneously acquired in-vivo magnetic resonance imaging (MRI). In this way it can be evaluated how physiological signals from the thoracic wall and internal structures, e.g., the heart, monitored by UWB-radar correlate with the physiological reality displayed by MR-imaging. [C118]

## "Delay-doppler ambiguity function of ultrawideband-throb signals"

The performance of ultrawideband (UWB) radar in target detection, resolution, and recognition depends on the structure of the radar waveform. In this paper, the principles of waveform diversity and design (WDD) for generating periodic and orthogonal UWB-impulse signals are described. A mathematical model for a UWB-throb signal that yields the practical advantages of the widely used linear frequency-modulation (FM) ldquochirprdquo signal is presented. The structure of the UWB-throb signal is designed based on a pulse-time modulation scheme. The delay-Doppler ambiguity function of the UWB-throb signal is derived for performance analysis. Computer plots of the UWB-throb signal, its autocorrelation function, and ambiguity function are generated to illustrate its characteristics and advantages for high-resolution impulse radar. [C119]

## "High resolution non-destructive testing in civil engineering by ultra-wideband pseudo-noise approaches"

Ultra-wideband sensing provides new and interesting options for testing and inspection in many different fields. The article will deal with some applications for civil engineering. The advantage of UWB-sensing is the good penetration of the sounding waves through the material under test and its high spatial resolution. A flexible UWB-sensor conception will be discussed. Its working principle is based on pseudo-random sounding waves. The examples considered shall indicate the device performance for quite different sensor tasks. [C120]

## "Resolution of UWB noise radar on basis of retrodirective antenna array"

Comparison of resolution and a side lobe level on delay (range) and azimuth in UWB noise radar with linear equidistant transmitting antenna array and the single receiving antenna is submitted at presence and absence of signal recirculation in a feedback loop transmitting element-target-receiving element. [C121]

## "Search and control of state of people under avalanches"

In the article principles of design of system for search people under avalanches which is equipped with sensor for determination of heart rhythm of people are discussed. Measuring of heart rhythm of people is possible due to Doppler effect. Detachment of Doppler frequency is based on homodyne method of conversion of signal. [C122]

## "Ultrawideband signals former with controlled time shift"

The former of ultrawideband signals with controlled time shift for the phased antenna array is developed. Formation of coherent harmonious signals with the necessary time shifts comparable to duration of a signal, is carried out by synthesizers of direct digital synthesis. Synchronization of synthesizers is carried out by signals of the common clock generator. Distribution of this signal carries out clock distributor. The former can be used in radar systems with use phased antenna array with excitation antennas elements ultrawideband signals with the set time shift. [C123]

## "Band properties of the highly rarefied arrays"

Width of the main lobe, directive gain and the antenna array pattern in the frequency range with covering 1:20 were calculated. The reasons of the distortion of the form and the spectrum of the ultrawideband impulse signal under radiating or receiving by the antenna arrays were analyzed. [C124]

## "Title page"

The following topics were dealt with: UWB antennas; electromagnetic compatibility; GPR; radar; propagation and scattering in natural and artificial media; electromagnetic metrology. [C125]

## "Symmetry in target recognition"

Symmetry has important consequences for target recognition. Rotation and reflection symmetry for targets near a ground or water surface not only help to identify the targets, but also aid in data processing to increase accuracy. While clutter (other scatterers) interfere with the target signatures, symmetry in the clutter can be used to suppress this interference. [C126]

## "Remote monitoring of human cardiorespiratory system parameters by radar and its applications"

The diagnostic monitoring of humans (as well as their detection behind of the opaque obstacles), by means of radar have called bio-radiolocation. As an illustration ultra-wideband (UWB) radar in medicine and in psychophysiology for remote measuring of patientpsilas heart activity and respiration is shown. The measuring method is described and practical results of tests are cited. New technical decisions on hardware and software which allow obtaining reliable physiological data at the monitoring of back-and-forth motion of objects are considered. This paper considers various applications of the bio-radiolocation. [C127]

## "Interference detection and rejection in ultra-wideband systems"

Ultra-wideband (UWB) communication systems appear promising for many wireless applications. However due to the restraint on their transmission power levels, UWB systems unavoidably suffer from the interference caused by the coexisting systems, making it extremely difficult/impossible to maintain adequate signal-to-noise-and-interference ratio (SNIR) levels. This paper presents a solution to this problem through use of agile filters to detect and eliminate narrowband interference. [C128]

## "Dosimetric implication of exposure of human eye to ultra-wideband electromagnetic pulses"

Despite an increase in the application of ultra-wideband (UWB) electromagnetic pulses in the communications industry, radar, biotechnology and medicine, characterization of bioeffects of exposure to non-ionizing UWB radiation is far from complete. In this paper the finite-difference time domain (FDTD) method is used to calculate the bioeffects resulting from the exposure of a human eye to UWB electromagnetic pulses in the frequency range of 3.1-10.6, 22-29, and 57-64 GHz. The results show that the interaction of UWB pulse with the eye tissues exhibits the same properties as the interaction of the continuous electromagnetic wave (CW) with frequency from the pulsepsilas power spectrum. It is also shown that under the same exposure conditions the exposure to UWB pulses is from one to many orders of magnitude safer than the exposure to CW. [C129]

## "Design and analysis of TEM horn antennas for ultra-wideband technology"

TEM horn antennas for ultra wideband (UWB) system applications are proposed in which offer unique advantages by their own structure characters. To realize ultra wideband and high gain operations, some antennas are designed and compared in this paper. By optimization, two classes of antennas can both realize the same radial character, get a satisfied gain and the bandwidth is enough for practical operation. As the UWB antenna, the group delay time is considered specially. The simulation results and analyses at 1-18 GHz frequency band of the TEM horn antenna are presented. [C130]

## "High power and linearity CMOS RFIC transmit-receive switch for ultra-Wideband radar and communication systems"

We report on the development of an ultrawideband fully-integrated T/R switch, fabricated on a commercial standard 0.18-mum CMOS process, with unprecedented performance. It occupies a very small die area of 230 mum times 250 mum. The new T/R switch employs an ultrabroadband topology based on the synthetic transmission-line concept with on-chip spiral inductors. Simultaneously floating and applying negative bias to the bulk or positive bias to the drain are implemented to enhance the linearity and power handling of the switch. The developed CMOS T/R switch exhibits an insertion loss lower than 1 dB from DC to 18 GHz and less than 2.5 dB up to 20 GHz. The measured isolation is between 32-60 dB, 25-32 dB, and 25-27 dB and P1dBvaries between 25.4-26.2 dBm, 22.6-25.4 dBm, and 19.8-22.6 dBm from DC-10 GHz, 10-18 GHz, and 18-20 GHz, respectively. The measured input third-order intercept point (IIP3) reaches as high as 41 dBm. [C131]

## "A new ranging application of UWB modulated by orthogonal waves in wireless sensor network"

In order to decrease the signal length and transmitting time, improve accuracy of the delay time estimate, complete the mission of ranging and communication at the same time, a new ultra wideband (UWB) ranging method is developed in this paper. This method modulates the training sequence and information signals respectively on two carrier waves which are orthogonal mutually, and then combines them to transmit. When the sensor receives the signal, it decomposes the signal with the characteristic of orthogonal waves to get the training sequence and information signals. On this condition, we design the system using this ranging method, analyze the factors which can improve the ranging performance, and simulate the system. The result of the simulation indicates that the system which uses this ranging method can transmit the training sequence and information signals at one time and improve the ranging performance observably. [C132]

## "The Implementation of the IEEE 802.15.4a MAC and Location Application System for Low Rate WPAN"

The ranging functions for the low rate WPAN have been one of the attractive issues to provide diverse applications. The IEEE 802.15.4a Task Group has specified alternative PHY and partially modified MAC using UWB signals to support more precise ranging accuracy. Based on the standard PHY and MAC of IEEE, this paper describes the implementation of the IEEE 802.15.4a MAC and for ranging and data communication functions. Also we suggest the location application system implemented with the indoor positioning algorithm and data processing functions, as well as data acquisition procedure from the end devices in the WPAN1. [C133]

## "Analytical, numerical, and experimental methods for through-the-wall radar imaging"

In this paper a physics-based approach for image formation of targets behind complex wall structures is presented. Analytical and numerical techniques are used for the development of forward scattering models which are then exploited in construction of matched filters for ultra-wideband synthetic aperture radars operating over a wide rang of incidence angles. Special scattering models for different wall types including cinder block and reinforced concrete walls are presented using efficient numerical and approximate analytical techniques. These allow for construction of SAR images as well as development of a refocusing algorithm. An experimental ultra-wideband radar is set up in the laboratory environment for the evaluation of the models presented. Also, a radar measurement configuration is proposed that allows for elimination of direct reflection from the walls. [C134]

## "Through wall radar imaging using UWB noise waveforms"

This paper examines the results of our research on the use of ultra-wideband noise waveforms for imaging objects behind walls. The advantages of using thermally generated noise as a probing signal are introduced. The technique of heterodyne correlation, used to inject coherence in the random noise probing signal and to collapse the wideband reflected signal into a single frequency, is presented. We address issues related to locating, detection, and tracking humans behind walls using the Hilbert-Huang transform approach for human activity characterization. The results indicate that noise radar technology combined with modern signal processing approaches is indeed a viable technique for covert high-resolution imaging of obscured stationary and moving targets. [C135]

## "Matched planar two-element antenna for ultra-wideband radiocommunication systems"

The paper presents theoretical analysis of two-element antenna for ultra-wideband application. Mathematical model of functional power parameters of general multiport array is introduced. Results of computer simulations of different matrices describing matched planar two-element microstrip antenna, power parameters and radiation

patterns are described. Problem of broadband matching and radiation of UWB signal is mentioned. [C136]

## "Ultra-wideband radar target modeling using triangular patch model"

To understand the UWB radar system, target scattering performance must be studied. As a widely used model in time domain electromagnetics triangular patch model (TPM) is employed to simulate UWB radar targets. But when the scattered fields are treated, singular points would occur of TPM. The singularity analysis is carried out of TPM and a method is proposed to deal with all kinds of singular points. The method proves effective through an application example. [C137]

## "Novel approach to ultra-wideband antenna design"

A novel approach to ultra-wideband (UWB) antenna design is presented which is based on a general description for the geometry of monopole antennas. This general description is capable of producing almost all possible shapes for monopole antennas and it is compatible with different optimization methods. The general description is used for the optimization of rotationally-symmetric monopole antenna with finite ground plane. The optimization of antennas is performed by applying a hybrid procedure, which begins with a global search and completes with a local optimization. The optimization procedure aims at minimizing the reflection from antennas while reducing the distortion of radiated pulses. In some cases, the reduction of variations in the energy pattern is also considered. The numerical results show the reliability and effectiveness of the whole process and considerable improvement in comparison with similar antennas reported in the literature. [C138]

## "Development of a power-efficient, high-gain, low-noise ultra-wideband 0.18-μm CMOS distributed amplifier"

A distributed amplifier with new cascade inductively-coupled common-source gain-cell configuration is presented. Compared with other existing gain-cell configurations, the proposed cascade common-source gain cell provides much higher gain. The new distributed amplifier, fabricated in TSMC 0.18-mum CMOS process, achieves an average power gain of around 10 dB, input match of less than -20 dB, and noise figure of 3.3-6.1dB with an unprecedented power consumption of only 19.6 mW over the entire ultra-wideband (UWB) band of 3.1-10.6 GHz. In the high-gain operating mode that consumes 100 mW, the new CMOS distributed amplifier provides an unprecedented power gain of 16 dB with 3.2-6-dB noise figure over the UWB range. [C139]

## "Lower bounds of moving target estimation in low frequency UWB SAR"

Lower bound of moving target estimation, in a multi-antenna channel ultra wide band (UWB) synthetic aperture radar (SAR) system is studied in this work. The main focus is to derive lower bound for systems having a very long integration time associated with position and velocity estimation, which is often connected to low frequency systems. Assuming a flat Earth model we consider the lower bound of the speed components in range and in the cross range direction. The estimation in cross range direction is associated with a considerable integration angle, and therefore the lower bound is determined in connection to a SAR process. It is found that the relative speed influences the covariance matrix of the clutter and therefore also the speed estimate. The influence increases the estimation performance of the relative speed and therefore also the performance of the cross range speed estimation. [C140]

## "A 100-960MHz CMOS Ultra-wideband Low noise Amplifier"

This paper presents the design and simulation of a CMOS ultra-wideband low noise amplifier. The amplifier exhibits a form of thermal noise canceling with a shunt-feedback topology for operating in the band of 100-960 MHz. It was designed using the AMI C5F/N (0.5 mum) process. Thorough simulations including anticipated parasitics predict a noise figure ranging from 1.84-2.45 dB, a forward gain of 11.5plusmn0.22 dB, and input and output matching metrics (S11 and S22) below -10 dB. [C141]

## "Direct radar positioning using strongly coupled ultra-wideband arrays"

We demonstrated radar positioning with the help of ultra-wideband arrays, based on a ldquodirect positioningrdquo approach. The method has been extended to the mitigation of the effects of mutual coupling, in terms of patterns diversity, by combining correlation functions obtained with different triplets of elements. Consistent solutions are obtained for the two approaches, which combine consecutive or non-consecutive elements. [C142]

## "GPR, radars"

{no data available} [C143]

## "Detection problem for searching survivors in rubble with UWB radars"

Detection theory for searching survivors in rubble with UltraWideBand (UWB) radars is being developed in the paper. An effective suboptimal detection algorithm has been synthesised and analysed. [C144]

## "Combined antennas for radiating ultrawideband short pulses"

Ultrawideband combined antennas optimized to radiate 0.2-ns length high-voltage (~100 kV) and low-voltage bipolar pulses have been developed. Linear arrays of low-voltage antennas were investigated in the mode of wide-angle steering by a wave beam. [C145]

## "Object recognition based on estimation of ultrawideband reflected pulse complex spectra"

A recognition method based on investigation of the complex spectra of ultrawideband pulses reflected from radar objects is suggested. An algorithm for complex spectrum estimation is described and a criterion according to which object identification is made is presented. Results of the algorithm approbation are given. [C146]

## "Deception jamming modeling in radar sensor networks"

In this paper we create a modeling scenario which includes an airborne imaging radar platform, receiving platform and an electronic countermeasure (ECM) platform whose goal is to introduce false target images. We also assume a high-resolution stripmap SAR model operating with several common types of UWB signals, as well as the newly proposed OFDM radar waveforms. OFDM-coded radar signals possess a viable quality of high pulse diversity potential, which can provide for robust performance in various jamming scenarios. In this paper, a method of jamming known as dasiadeceptionpsila is considered and a jammer model which aspires to generate false targets using intercepted radar signals is used. Two approaches to creating a radar signal by the jammer are considered: instantaneous frequency (IF) estimator and digital RF memory (DRFM)-based reproducer. In both cases, the jammer aims to create a copy of a valid target image-but located elsewhere in the observed target scene-via resending the radar signal at certain time intervals. Radar imaging simulation based on backprojection algorithm in presence of a deception jammer is performed for the cases of linear frequency modulated (LFM), short-pulse Gaussian, frequency-hopped (FH) and OFDM ultrawideband waveforms. The comparisons in ECCM performance of these signals are made based on the analysis of simulated imagery. [C147]

## "The simulation and analysis of the interference from ultra-wideband system to spread spectrum communication system"

Ultra wideband (UWB) system operates by transmitting signals over a very wide band of spectrum, so there must be the problem of coexistence of UWB with other radio services besides the spread spectrum communication system. By designing the simulation models of UWB system and spread spectrum system which is used more broadly, the simulation experiments has been taken on the performance of spread spectrum under the interference from UWB. The results prove the validity of simulation model. And the main factors are analyzed on UWB interference to the spread spectrum communication, and the corresponding results are given. [C148]

## "Novel variable spreading sequence length system for improving the processing speed of DS-UWB radar"

A vehicular radar is an essential device to reduce traffic accidents. As such a radar, direct sequence-ultra wideband (DS-UWB) radar has been studied in recent years. It could detect the target at a high resolution. In order to apply the DS-UWB scheme to the vehicular radar system, we need to measure the distance between vehicles at high speed and control the vehicles with enough time margin. However, we have to enlarge the spreading sequence length very much to extend maximum detectable distance because the DS-UWB scheme use extremely short pulses that is 1ns. Therefore, we need to speed up correlation processing time in the case of measuring long distance. Research done to answer this needs has been scarce until now. In this paper, we propose a variable spreading sequence length system in order to improve accuracy and reliability by increasing the update rate of data of distance between vehicles. Some simulation results show that ranging time and accuracy could be improved by the proposed system. [C149]

## "Shock Wave Simulation of Ferrite-Filled Coaxial Nonlinear Transmission Lines"

Ferrite-filled coaxial shock lines have recently been used to significantly decrease the rise time of a high voltage

pulse. This decrease can be enhanced by initially axially biasing the ferrite material with an applied external magnetic field, allowing for a faster transition from the unsaturated to the saturated state. The simulation of the ferrite material's operation, including saturation, is discussed as well as the simulation of coaxial nonlinear transmission lines. The project explores the rise time changes with variations of magnetic bias, ferrite geometry, input signal characteristics, and transmission line characteristics. Simulated waveforms are discussed for a nickel-zinc ferrite-filled coaxial line. The pulse steepening effect observed in electromagnetic shock lines occurs primarily because of an increase in phase velocity for points higher on the waveform due to the saturation of the ferrite material. An incident pulse of high enough amplitude will drive the ferrite material into saturation, decreasing the relative permeability to one. This saturation front propagates through the ferrite material in the direction of the incident wave until the entire material is saturated, producing a sub-nanosecond rise time pulse. The shock line is designed for a saturated impedance of 50 Ohms to couple easily into existing systems. Pulsed operation of up to low kilohertz repetition is desired and being explored. Applications of electromagnetic shock lines include laser triggering and ultra-wideband radar generation, as well as others. [C150]

## "Classification of suspicious regions within ultrawideband radar images of the breast"

Ultrawideband (UWB) radar is one of the most promising emerging technologies for breast imaging. Several algorithms have already been developed which exploit dielectric contrasts between normal and malignant tissue. These algorithms have been tested on anatomically accurate models of the breast. However, the recently established similarities in dielectric properties between benign/fibroglandular and malignant tissue within the breast contribute to the occurrence of 'false positive' results in UWB images. To mitigate the presence of these 'false positive' results, we must investigate methods to further classify tumours based on their shape, size and texture. In this paper we review the dielectric properties of normal and malignant breast tissue and existing image algorithms. Finally, we examine methods to effectively differentiate benign/fibroglandular and malignant tissue based on shape, size and texture. [C151]

## "Ultrawideband radar detection of soundings signals using wavelet-transform"

Detection of soundings ultrawideband radar (UWB) signals embedded in non-stationary interference presents a difficult challenge. In this paper, analysis of synthetic signals and UWB radar data is performed using time-scale methods, such as the a discrete wavelet transform (DWT) on based Mallat's algorithm. The performance of these methods is compared and the characteristics, advantages and drawbacks of each technique are discussed. [C152]

## "Miniaturization of ultra-wideband antennas"

This talk briefly introduces design challenges of ultra-wideband (UWB) antennas. An outlined of special design considerations are presented from a systems point of view, followed by some state-of-the-art solutions. Then, the miniaturization technology of UWB antennas is addressed. The planar designs are highlighted due to their unique merits and wide adoption in applications. First, the ground plane dependence of the antenna performance in small antenna design is addressed. Using a newly developed technique, the dependence of small antenna performance on system ground plane is alleviated. A design example is used to elaborate the mechanism of the method. Based on this concept, the antenna with further reduced size is designed to fit the size of wireless USB dongle. Furthermore, an innovative compact diversity UWB antenna shows the advantage of ground-independence small antenna in diversity applications. Last, a UWB antenna integrated with bandpass filter is proposed to reduce the overall size of devices by using the concept of co-design. In the end of the talk, the trend of UWB antenna R&D is offered according to application and market demands. [C153]

## "Airborne Measurement of Snow Thickness over Sea Ice"

Snow cover on sea ice plays an important role in the climate of the polar regions. Snow on the sea ice reduces the heat exchange between the ocean and the atmosphere by its high albedo and low thermal conductivity. The lower the albedo, the less solar energy is reflected back into the atmosphere. Data on the extent and thickness of snow cover is needed to understand the condition and future behavior of sea ice. Remote sensing is a commonly used means of observing snow cover over sea ice. The advanced microwave scanning radiometer (AMSR-E) is one instrument for accomplishing this objective. To validate measurements made by AMSR-E, the University of Kansas developed an ultrawideband frequency-modulated continuouswave (FM-CW) airborne radar to measure snow thickness over sea ice. The University of Kansas tested their radar system on board the NASA P-3 aircraft during the NASA Arctic 2006 Field Campaign over the Alaskan coastal region. The objective of this field campaign was to acquire a comprehensive data set that will enable validation of the snow thickness retrieval algorithm AMSR-E passive microwave sensor measurements on board NASA's AQUA satellite. This paper contains the preliminary results of resolving the air/snow interface and the snow/ice interface. [C154]

## "Maritime target cross section estimation for an ultra-wideband forward scatter radar network"

Preliminary investigation has shown that a chain of buoy based ultra-wideband (UWB) forward scattering radar (FSR) transceivers could potentially be used to overcome clutter problems for the detection of small marine targets on the sea surface. As one stage of a more in depth system investigation, it was deemed that a thorough analysis of the forward scatter radar cross section (RCS) of typical small maritime targets is required for full understanding of the radar system performance. This paper describes the preliminary results of this study, through use of numerically simulated 3-D FS RCSpsilas of complex target models and comparisons with a proposed simplified analytical FS RCS description. [C155]

## "Detection and tracking of moving or trapped people hidden by obstacles using ultra-wideband pseudo-noise radar"

Efficient detection of people hidden by walls or rubble is of interest for rescue, surveillance and security operations. A useful method applies an ultra-wideband radar approach for this purpose since electromagnetic waves in the lower GHz-range penetrate most non-metallic materials. The paper gives a short overview of the particular radar conception and shows some experimental results for the tracking of people, detection of breathing people and reconstruction of room interiors. [C156]

## "Weighted cooperative sensing for pulse radar signals"

In this paper, the sensing performance implemented by a secondary cognitive system on a primary system (pulsed radar) is investigated. Firstly, the sensing performance considering the detection probability and the false alarm probability is presented analytically in a local single node for energy detection. Secondly, the sensing performance of a standard cooperative sensing algorithm is presented. To further improve the performance of cooperative sensing, a weighted cooperative sensing algorithm is proposed considering two criteria, the local constant false alarm rate (LCFAR) and the local constant detection rate (LCDR). Performance results indicate that under the same criteria, the sensing performance of the weighted energy sensing algorithm is better than the standard energy cooperative sensing algorithm. [C157]

## "Interference analysis of UWB to the satellite communication services"

UWB communication system operates by transmitting signals over a very wide band in spectrum, so there must be a coexistence problem between UWB and the other radio services. In order to investigate the interference to the narrowband wireless services from the UWB devices, a novel three-dimensional projection interference model has been presented. This analysis model is fit for analyzing the interfered equipments which have high gain and sharp-cut directional character by making the projection and the directional weight for UWB distributing. Based on the proposed model, the interference from UWB equipments to the satellite communication services has been analyzed and the limitations on the UWB transmit power in C-band has been regulated by simulation. [C158]

## "Analytical representation for 3D fields of antenna radiation in problems of georadar sounding"

This paper describes algorithmization representations for field of radiation of the antennas applied in GPR scanning of subsurface structures, in stratiform and two-layer soils in three-dimensional approach. Results include asymptotic representations for fields on small distances from the antenna and analytical representation for a superficial wave. Asymptotic representations of field allow eliminating singularity in numerical modeling, to consider field influence on a current in the antenna during solving of three-dimensional inverse problem of GPR-location. Asymptotic representation of superficial wave field allows to reduce time of solution finding in inverse problems of GPR scanning and to clear data of the observable reflected field. [C159]

## "An approach of detection the structure of subsurface layers using reflected GPR signals"

An approach, allowing correct detection of the structure of the sounding ambience using GPR signals is suggested. [C160]

## "Pulse radiolocation by means of two-dimensional antenna arrays"

A method for reconstruction of earth surface and detection adjacent objects from redundant data and by means two dimensional antennas array as transmitting and receiving systems is described in this paper. An interpretation of radiolocation images (RI) was done and main classification factors of adjacent object were presented. [C161]

## "A method of RCS determination in time-domain"

Presently, in the UWB radars operation there is no rigorous and commonly accepted pattern of describing the reflection characteristics of a target. Since the target reflection characteristics depend considerably on a radar configuration, it seems reasonable to employ some analogue to the classical RCS sigma' (t), which does not dependent on the distance to target, on the characteristics of Rx and Tx pulse antennas and the amplitude of a pulse exciting the Tx antenna, and which has the dimension of area. The procedure below is proposed in order to determine this characteristic. A simplified structure of the radar is shown in Fig. 1. The pulser 1, using a feed, excites the Tx pulse antenna. The form of the antenna excitation pulses is supposed to be known, and, as shown below, their amplitude is to be unimportant. A pulse of unknown temporal characteristics is excited at the output of the Tx pulse antenna. The directivity characteristics of the Tx pulse antenna are also unknown. Some analogue of this antenna power gain is denoted with gtx. The target 3 is placed at a fixed range R0under the desirable slant in the direction of the radiation maximum. The field scattered by the target incidents on the aperture of the Rx pulse antenna 4 as some pulse of unknown characteristics; the directivity characteristics of this antenna are characterized by grxparameter. The Rx pulse antenna 4 converts the electromagnetic pulse into an electric one. As a result, the ultra-short power pulse P1(t) is dissipated over the load, and the amplitude and form of this pulse are registered. [C162]

## "Radiation properties of ultra-wideband printed-board antennas: Simulations and experimental verification"

This paper presents some results of the work done within the frameworks of the ISTC project #B-922. The simulation data and experiments demonstrate possible techniques of improving characteristics of planar ultra-wideband (UWB) antennas based on the tapered slotline. To this end, four ultrawideband baluns, namely the 4th-order Marchand balun, microstrip to slotline transition with open cavity, two designs of radial stub baluns, and three types of aperture such as exponential Vivaldi type, elliptical flare with corrugated edges and elliptical open flare had been studied. Several planar UWB antennas with dimensions of 23 to 12 centimeters were simulated using electromagnetic simulation software, and then designed, fabricated and tested. The simulation and experimental results on the evaluation of the bandwidth and radiation pattern of the antennas are presented. [C163]

## "High decoupled antenna for UWB pulse GPR "ODYAG""

A principle of operation and arrangement of UWB antenna system which differs from other with very high frequency independent electromagnetic decoupling are described in the paper. Peculiar design of the antenna makes it possible to use it in two different modes-horizontal scanning mode and accurate definition of local object location mode. The antenna system is designed for the ground penetrating radar ldquoODYAGrdquo monitoring of subsurface structure of asphalted roads. [C164]

## "Passive VHF radar: Antenna design and optimization requirements"

Passive radars are under investigation due to its interesting potentiality: the use of independent sources is possible for the large diffusion of high power broadcasting stations. VHF stations guarantees high power and wide coverage areas. Consequently to large wavelength in this band, the antenna systems design is fundamental. The study leads to the interferometry configuration of a passive radar, configured as a couple of antennas. In order to maintain the maximum accuracy of the radar system, it is fundamental the optimization of the antenna system, including all the embedded effects. The mathematical approach is discussed and the optimization target are defined. Example of design and optimization studies are presented. [C165]

## "0.13-μm SiGe BiCMOS radio front-end circuits for 24-GHz automotive short-range radar sensors"

This paper presents the key blocks of a 24-GHz front-end for vehicular short-range radar sensors implemented in a 0.13-mum SiGe BiCMOS process. In particular, a three-stage low-noise amplifier with transformer-based loads, a frequency synthesizer, consisting of 24-GHz voltage-controlled oscillator in closed loop with an N-integer PLL, and an ultra-wideband transmitter based on a RF current steering switch are detailed. The low-noise amplifier provides an outstanding power gain of 35 dB and a noise figure as low as 3.4 dB, guarantying an input 1-dB compression point of -12 dBm. The transmitter is able to deliver 0-dBm output power at 24 GHz, complying with 1-ns pulse transmission requirements. [C166]

## "Compact band-notched ultra wideband printed monopole antenna"

A simple and compact microstrip-fed ultra wideband (UWB) printed monopole antenna with band-notched performance is proposed in this paper. The antenna is composed of a cirque ring with a small strip bar, so that

the antenna occupies about 8.29 GHz bandwidth covering 3.18-11.47 GHz with expected band rejection of 5.09 GHz to 5.88 GHz. A quasi-omnidirectional and quasi-symmetrical radiation pattern is also obtained. This kind of band-notched UWB antenna requires no external filters and thus greatly simplifies the system design of UWB wireless communication. [C167]

## "Numerical research of the radiation of the UWB antenna array"

Applying the electromagnetic numerical method, the radiation characteristic in time domain of the electric-magnetic vibrator combined ultrawideband (UWB) antenna array was investigated. The power pattern and radiated character on main axis of different arrays structure and space were analyzed. The coupling between the antenna units was estimated through comparing it with no-coupling model. The results indicate that the electric-magnetic vibrator combined UWB antenna array can improve antenna direction and radiated character on main axis. [C168]

## "Contributions to the electromagnetic theory by Henning F. Harmuth and one analogy in the history of electrodynamics"

Considerable nontrivial contributions that have been done by Henning F. Harmuth to electromagnetic signal theory and UWB radar and Communication systems are briefly described in the paper. An interesting historical analogy in scientific life of Henning Harmuth and Oliver Heaviside is traced. [C169]

## "Pulse electromagnetic wave scattering by plane dielectric interface"

Results of numerical simulation of pulse cylindrical electromagnetic wave scattering by a dielectric half-space with a plane interface have been presented in the given work. This simulation has been done by the finite-difference time-domain method (FDTD). A change of field characteristics with changing the radiator position and observation points as well as radiated pulse duration and dielectric characteristics of the scatter has been investigated. A possible effect of these parameters on the probability of subsurface object detection in radar problems has been considered. [C170]

## "Distortion of pulsed input signal in finite-difference time-domain grid"

We consider propagation of pulsed input signals in finite-difference time-domain grid. Factors that influence upon these signals distortion have been analyzed. Relatively simple finite-difference time-domain computing algorithm is used for this purpose. The way for quantitative sizing of input signal distortion has been proposed. [C171]

## "Microwave multifrequency radar images of dielectric structures"

The results of microwave measurements for some objects combining multifrequency measurements and transversal scanning is presented. Longitudinal distance dependencies of reflectivity have been obtained by synthesis from multifrequency data. The multifrequency measurements and synthesis have been done in real-time. The measurements in free space were carried out by the apparatus using measuring modules of scalar reflectometer of series P2 (R2). The combination of data in longitudinal and transversal directions produced radio images of some dielectric structures. [C172]

## "UWB Reference-Free Self-Positioning with Electrical Scanning Directional Antenna"

An Ultra-Wideband (UWB) self-positioning system and its architecture are presented. It consists of a pulse-based transceiver for ranging from the surrounding objects, an electrical scanning antenna for direction detection, and baseband positioning algorithms. Self-positioning can be performed by using the ranging and direction information based on reflected signals in a room environment. It can also determine its own position in the presence of some blocking objects by employing the so-called multi-layer reflection algorithm. This reference-free self-positioning system operated in an office meeting room is shown to be capable of achieving 30 cm positioning accuracy with the 70% bound. [C173]

## "Recent Advances and Applications of M-Sequence based Ultra-Wideband Sensors"

Ultra-wideband (UWB) sensing is an upcoming technique to gather data from complex scenarios such as nature, industrial facilities, public or private environments, for medical applications, non-destructive testing and many more. Currently it is hard to estimate the full spread of future applications. The measurement approach traditionally used is based on stimulation of the test objects by either short sub-nanosecond impulses or sine waves which are stepped/swept over a wide spectral band. This paper deals with an alternative approach, which uses very wideband pseudo-noise binary signals such as M-sequences for example. Such devices have a very

high time stability, enable high measurement speed and do not burden the test objects with high voltage peaks. Furthermore, the device concept promotes monolithic circuit integration in a low cost semi-conductor technology. In what follows, the basic device concept and some extensions will be considered as well as some selected applications will be discussed. [C174]

## "Ultrawideband hybrid EBG/ferrite ground plane for low-profile array antennas"

Ultrawideband and low-profile antennas are considered a most critical component in the development of low-band systems such as airborne foliage penetrating radar and EW applications. For these applications it is clear that an ultrawideband and low-profile ground plane needs to be developed and implemented to achieve the desired specifications and enhanced performance. In this paper a novel ultrawideband and low-profile hybrid EBG/ferrite ground plane is presented. The hybrid ground plane design offers ultrawideband operation beginning in the 100s of MHz with the presented design version offering an operational bandwidth exceeding 22:1 starting at 170 MHz. The use of this ground plane will allow for the practical and effective implementation of the new highly sophisticated and ultrawideband antenna systems developed at Raytheon. [C175]

## "UWB transmission characteristics of bow-tie antennas on Si"

Transmission characteristics of bow-tie antennas, which were fabricated on silicon substrates, were investigated for a mobile ultrawide-band (UWB) microwave radar. Bow-tie antennas, which have different antenna lengths and flare angles, were fabricated on a Si substrate having resistivities of 10 Omegaldrcm, 79.6 Omegaldrcm and 2.29 kOmegaldrcm. Using bow-tie antennas with antenna length of 5.37 mm and flare angle of 53deg, the waveform and propagation characteristics were measured. S21increased with increasing the resistivity of Si substrate, and S21of -20 dB was obtained for bow-tie antennas with 10 mm distance fabricated on Si chip having the resistivity of 2.29 kOmegaldrcm. [C176]

## "Radar Polarimetry for Target Discrimination"

Discrimination of targets vs. clutter is critical to many radar identification problems. For the purpose of Improvised Explosive Device (IED) detection, radar range profiles and images are valuable to capture the target of interest; it remains a big challenge to differentiate the target from the surrounding man-made clutter. The goal is to reduce the clutter. It is well-known that vector wave scattering is sensitive to both wave polarization and target orientation. This work makes use of ultra-wide-band (UWB) radar technology and polarization diversity to characterize targets with polarimetric signatures. The results were based on both radar measurement and electromagnetic simulation. This research demonstrated the effectiveness of radar polarimetry for improved target identification. [C177]

## "An Ultrawideband Radar Based Pulse Sensor for Arterial Stiffness Measurement"

A novel pulse sensor based on ultrawideband (UWB) radar to detect the arterial vessel movements on various sites on human body without applying external pressure on the arterial vessel was designed and evaluated for aortic stiffness measurement. The UWB pulse sensor was evaluated for its functional performance and human study was carried out to validate the UWB sensor as a tool for clinical screening of subjects with cardiovascular risks. Good agreement in measurement of pulse wave velocity, an index of arterial distensibility, was achieved between the UWB pulse sensor and the applanation tonometer. [C178]

## "The Research Activities of Ultrawide-band (UWB) Radar in China"

The UWB signals for radar applications can be generated from time domain or frequency domain. Because of the limited energy, the time domain UWB signal or impulse signal is usually applied for short range radar, such as ground penetrating radar(GPR) and through-wall-imaging radar(TWIR). In opposition to it, the frequency domain UWB signals can be applied both for short-and far-range imaging radar, such as GPR, TWIR or airborne UWB synthetic aperture radar(SAR). The UWB radar research has been carried out from 1980s in China. But its really flourishing and mature era was from the middle of 1990s. This paper reviews the Chinese archives and the most recent results in UWB radar both for time domain and frequency domain. [C179]

## "Detection and recognition of radar objects at sounding by high-power ultrawideband pulses"

By present, ultrawideband (UWB) radiation sources with megavolt efficient potential have been created. This is technical basis for development of UWB radars for remote object sounding. The paper gives special attention to analysis of investigation results of methods for detection and recognition of remote radar objects at sounding by high-power UWB pulses. To detect UWB signals at the noise and interference background, an approach based on the joint use of matched filtering and inter-period correlation processing is suggested. A genetic function

method and parametric methods were developed for object recognition. Compression of the data bank is of importance in the latter methods. [C180]

## "Radiation of planar stripline ultra-wideband antenna for WPAN systems"

The paper presents results of design and computer simulation of planar monopole pulse ultra-wideband (UWB) antenna for WPAN applications. A complex approach to design of UWB antennas was used. Problem of radiation of UWB signals by the antenna was discussed. Electric fields radiated by the antenna for chosen directions were calculated and shown. [C181]

## "Refocusing through single layer building wall using synthetic aperture radar"

Through-wall imaging using synthetic aperture array technique is studied by employing ultra-wideband antennas and for wide incidence angles. The effect of the building walls on the target image distortions is investigated by simulations and measurements. It is shown that using the idea of match filtering, the effect of the wall can be compensated for and point target response can be reconstructed. A controlled experiment within the laboratory environment is performed to verify the methods, presented. It is shown that for an ultra-wideband system operating over frequency band of 1-3 GHz highly distorted images of two point targets in close proximity of each other behind a wall can be resolved after refocusing. A dual-frequency synthetic method is also presented that can improve the cross- range resolution of the refocused image. [C182]

## "Ultra Wideband Antennas for In-Pipe Ground Penetrating Radar"

The design of an ultra wideband antenna for a ground penetrating radar system presents additional challenges to those for communication systems. In particular a novel in-pipe deployment requires the antenna to be placed in a buried pipe, and its width is greatly restricted. In this paper several antenna configurations are examined to meet these requirements. A dielectric loaded base tapered dipole configuration and a loaded folded dipole are seen to offer the best performance for this application. [C183]

## "On the Design of a Thin-Wire Bow-Tie Antenna for GPR using Evolutionary Optimization Algorithms"

In this communication we compare the performance of classical genetic algorithms (cGA) with a new type of evolutionary algorithms named hybrid Taguchi genetic algorithms (HTGA) when they are applied to the design of a a new ultrawideband (UWB) thin-wire bow-tie antenna for GPR applications. The broadband performance of the antenna is achieved by resistive loading and by optimizing the number of wires and the angular distances between those wires. [C184]

## "UWB communication using fractal signals"

In recent years, the electromagnetic environment has radically changed worldwide because of numerous sources of high-power electromagnetic signals, which interfere with information-carrying signals and, thereby, considerably distort them. As a result, a wide-band background electromagnetic field is present in the environment, with its strength often much higher than that of natural electromagnetic fields. Such a situation places more stringent requirement on transmitting/ receiving equipment and its operational maintenance. Therefore, of primary concern in the design of modern communications is to ensure a high immunity against different types of noise. A solution to this problem may lie in using those systems handling fractal ultra wideband (FUWB) signals. This type of UWB signals has multiband fractal spectra with exact top and lower boundaries. FUWB signals were created with maximum width of spectrum equal to 640 MHz. FUWB signals are not only ensuring a high protection of information against electromagnetic fields but also prevent unauthorized. Thereto multiband fractal antennas and fractal filters were developed. Fractal signals were generated and transmitted (in air or via 50 m cable) with a carrier frequency at 2 GHz and more. Using FWB signals and recent advances in electronic technologies a new fractal communication system was created and successful experiments were carried out. [C185]

## "Application of particle swarm optimization to ultra-wideband multistatic radar used for protection of indoor environment"

A numeric simulation of a multistatic radar using the finite-difference time-domain (FDTD) method and particle swarm optimization (PSO) is implemented in order to localize an intruder inside a laboratory complex. In order to obtain high resolution and to avoid interference with other radiosystems, the radar operates with ultra-wideband pulses and spectral spreading. The transmitted signal has a spectral peak at 1 GHz and the bandwidth of approximately 1 GHz. To estimate the location of the target, two transmitters and nine receivers are used. The

transmitters operate in TDM mode in order to avoid interference between them. [C186]

## "Subaperture wiener filter construction for time-varying RFI suppression in UWB SAR"

Ultra-WideBand synthetic aperture radar (UWB SAR), operating in the very high frequency/ultra-high frequency bands, has foliage and ground penetrating capability to detect targets hidden in forest or under the ground. The existing services such as television, radio and communications, referred to as radio frequency interference (RFI), degrade the quality of focused UWB SAR image. The Wiener filter has been found to have superior suppression performance and be more computationally efficient than other RFI suppression methods but its construction needs additional recorded RFI data, which increases the radar system complexity. In this paper, a subaperture Wiener filter (SWF) construction method is proposed, which does not require additional recorded RFI data and can deal with the time-varying RFI. The proposed SWF has been proved efficient by real UWB SAR data. [C187]

## "Feasibility study of a multi-carrier dual-use imaging radar and communication system"

The paper describes a modelling scenario aimed at exploring high-resolution imaging, communication and in-band coexistence with other signals potential of a multi-carrier radar/communication system based on ultra-wideband waveforms obtained via orthogonal frequency division multiplexing (OFDM). Imaging performance is simulated for a well-studied scenario of stripmap SAR, for which backprojection algorithm is used in image reconstruction. The case of two airborne platforms is considered and image data communication between the platforms is modelled. This feasibility study lays foundation for subsequent analysis of a multi-platform sensor network scenario based on novel ultra-wideband radar architectures. [C188]

## "An Analysis of 2D Target Positioning Accuracy for M-sequence UWB Radar System under Ideal Conditions"

This paper describes analysis of target positioning accuracy for ultra wideband (UWB) maximum length binary sequence (M-sequence) radar system under ideal conditions in two dimensional space. In this case, it is shown that the target position estimation error is cased by quantization of time of arrival (TOA) measured by the radar system. The appropriate statistical quantities are suggested for describing these errors. The properties of M-sequence UWB radar systems performing under ideal conditions are illustrated by a set of simulations. The results obtained in this paper can be applied as a base for the design of positioning system based on M-sequence UWB radar. [C189]

## "Moving Target UWB Radar Demonstration using Real-Time Sampling"

Moving target bistatic 2D UWB radar trial with two receiving antennas using modification of time-domain back-projection technique with use of 50 GHz equivalent sampling oscilloscope in comparison of two channel 1 GHz real time sampler is presented. Sub nanosecond first derivate Gaussian pulse with peak-peak amplitude 1.2 V was used. As a target a metal barrel was chosen and his movement by shifting with 5 cm step simulated. Using real-time sampler was the goal. Acquired data were processed and the radar images shown. [C190]

## "22-29GHz Ultra-Wideband CMOS Pulse Generator for Collision Avoidance Short Range Vehicular Radar Sensors"

The pseudo millimeter wave 22-29GHz ultra-wideband (UWB) is attractive for the applications in short-range (SR) automotive radar sensors in order to contribute to significant reduction of traffic fatalities. Although CMOS is suitable for the short-range radar since processing units can be implemented in the same chip with the UWB front-end building block, it is difficult to operate CMOS pulse generators at such a high frequency. To realize the pseudo-millimeter-wave band using CMOS, we have proposed a new pulse generator consisting of a series of delay cells and edge combiners with waveform shaping. As a result of measurement using 90nm CMOS technology, 1Gbps pulses are successfully generated with a power consumption of 1.4mW at a supply voltage of 0.9V. This result is the key technology for a one-chip SR cost effective radar sensors. [C191]

## "Hilbert-Huang Transform (HHT) Processing of Through-Wall Noise Radar Data for Human Activity Characterization"

Different parts of the human body have different movements when a person is performing different physical activities. Also, there is great interest to remotely detect human heartbeat and breathing for applications involving anti-terrorism and search-and-rescue. Ultrawideband noise radar systems are attractive because they are covert and immune from interference. The conventional time-frequency analyses of human activity (usually including the short time Fourier transform (STFT), Wigner-Ville distribution (WVD), and wavelet analysis) are not generally adaptive to nonlinear and nonstationary signals. If one can decompose the noisy baseband signal containing

human Doppler information and extract only the human-induced Doppler from it, the identification of various human activities becomes easier. We therefore propose to use a recently developed method, the Hilbert-Huang transform (HHT), since it is adaptive to nonlinear and nonstationary signals. When used with noise-like radar data, it is useful for covert detection of human movement. The HHT based signal processing can effectively improve pattern recognition and reject unwanted uncorrelated noise. [C192]

## "A SiGe-BiCMOS UWB Receiver for 24 GHz Short-Range Automotive Radar Applications"

This paper presents a SiGe receiver IC for 24 GHz short-range automotive radar based on pseudo-noise code modulation. An on-chip 48 GHz LC-VCO plus frequency divider generate the 1/Q clock signals for zero-IF down-conversion. The 24 GHz output signal of the first frequency divider is available off-chip as carrier for the accompanying transmitter IC. The IC includes two LNAs with built-in single-ended to differential conversion. On-chip coplanar transmission lines on a ground shield are used extensively throughout the IC for distribution of RF and clock signals. The 1.5x1.7 mm2receiver IC is implemented in a SiGe:C BiCMOS process withf tau/fmax = 130/140 GHz. The IC achieves a measured DSB noise figure below 7 dB across a 2.5 GHz DSB IF bandwidth, with a conversion gain of 39 dB. [C193]

## "Waveform design and modulation schemes for impulse communications and radar"

Ultrawideband impulse radio communication is based on the classical principles of pulse time modulation conveniently used for baseband transmission. In this paper, we present the principles of impulse waveform design, impulse time modulation for information transmission process, period-staggering modulation scheme for multiple access applications, and M-ary impulse modulation. Periodic and orthogonal non-sinusoidal impulse waveforms are generated in terms of the periodic and orthogonal sinusoidal waveforms. The conventional analog and digital modulation schemes that are based on the use of sinusoidal carrier waveforms are applied to nonsinusoidal impulse waveforms. As illustrative examples, M-ary impulse modulation schemes are described, i.e., M-ary phase shift keying (M-PSK) and M-ary frequency shift keying (M-FSK). The design of a linear FM "chirp" impulse waveform for radar applications is presented too. [C194]

## "Hilbert-Huang Transform (HHT) Analysis of Human Activities Using Through-Wall Noise Radar"

Various parts of the human body have different movements when a person is performing different physical activities. There is a need to remotely detect human heartbeat and breathing for applications involving anti-terrorism and search-and-rescue. Ultrawideband noise radar systems are attractive because they are covert and immune from interference. The conventional time-frequency analyses of human activity are not generally applicable to nonlinear and nonstationary signals. If one can decompose the noisy baseband reflected signal and extract only the human-induced Doppler from it, the identification of various human activities becomes easier. We propose a nonstationary model to describe human motion and apply the Hilbert-Huang transform (HHT), which is adaptive to nonlinear and nonstationary signals, in order to analyze frequency characteristics of the baseband signal. When used with noise-like radar data, it is useful covertly identify specific human movement. [C195]

## "Ultrawideband Signal Processing Algorithms for Radars and Sodars"

In this paper we use statistical approach to synthesize algorithms for digital signal processing in UWB noise radar and sodar. Parametrical and non-parametrical algorithms are synthesized and analyzed. Experimental check is done on the basis of developed acoustic physical model which is used to build a noise sodar prototype. Developed algorithms can be used in noise radars for different applications. The use of the UWB noise signal provides a very high resolution both in speed and range [C196]

## "Peculiarities of Videopulse Scanning Antenna Array Design"

Consideration is given to details of construction onboard active videopulse scanning antenna array (VPSAA) for radio-location applications. The influence of the relative sizes and the directional characteristics of individual radiators, their relative positioning on ability to maintenance of electronic scanning VPSAA in the necessary sector of space are investigated. Comparison of the directional characteristics and scanning ability of continuous aperture and antenna array is resulted [C197]

## "The GPR Response of a Subsurface Objects and its Use for Target Detection"

The present work reports the results of laboratory measurements of the real part of dielectric permittivity epsiv' and dielectric loss tangent tg(delta) of sandy and clayey soils as a function of soil moisture (X) uniformly distributed throughout the volume and of electromagnetic field frequency. Also, the theoretical research of the

dependence the reflected signal shape on the humidity profile was realized [C198]

## "UWB Radars for Chalenging Applications"

A number of challenging radar applications (such as antipersonnel mine detection and human being detection) has been discussed. In these applications UWB technology has a number of advantages of over the traditional narrow-band approach, in particular very high positioning accuracy, rigidity to multi-path propagation and target classification abilities. On a number of examples recent advances of UWB technology in radar have been demonstrated and remaining challenges have been discussed [C199]

## "Ultrawideband Signals: Theory, Simulation and Digital Processing"

The propagation of the pulse ultrawideband (UWB) signals in plasma media, in particular, in the near-to-Earth's plasma layers was simulated. The dispersive distortions of the UWB signal in that media were estimated. The absorption dispersion and the scattering dispersion were taken into consideration. The radar equation for the distributed target location with UWB signals was modified. The wavelet analysis of the UWB signals was performed. The obtained results with the results of the short-time Fourier transform processing were compared and in new specially constructed format were shown. New set of the analytical wavelets based on the atomic functions and called as the Kravchenko-Rvachev analytical wavelets was proposed. Two new types of UWB signals called as non-linear and fractal UWB signals were suggested. Numerical characteristics for created models of that UWB signal types were calculated. Two time-frequency transforms were proposed to apply for UWB signal analysis [C200]

## "Practical Application of Ultra-Wideband Radars"

The possibility of ultra-wideband (UWB) radar use in various fields for remote measuring of the object's motion at short distance is considered. As an illustration UWB radar in medicine for remote measuring of patient's heart activity and respiration is shown. The measuring method is described and practical results of tests are cited. The opportunity of radar application in the other areas is described [C201]

## "Development of Surveillance and Tracking Radar"

A high-resolution surveillance and tracking radar has been recently developed and tested at the Institute of Radio Astronomy. The radar is a monopulse, all-weather radar with mechanical beam steering. It works in a pulse mode, and a coherent FFT-based signal processing is utilized. The radar is equipped with a clutter suppression system and with a Kalman filtering scheme for trajectory calculation and extrapolation. The radar is suitable for long-range surveillance with a small volume-scanning time and for tracking of highly dynamic, low-sized targets. This paper describes the setup of this radar, its main components, and the signal processing technique used [C202]

## "Coexistence of Transmitted-Reference UWB System and IEEE 802.11a WLAN"

Transmitted-reference (TR) ultra-wideband (UWB) systems can relax the difficult synchronization requirements and can provide a simple receiver architecture that gathers the energy from many resolvable multipath components. However, TR-UWB systems are susceptible to interference which comes from other wireless systems. In this paper, TR-UWB system performance is studied in the presence of strong IEEE 802.11a WLAN interference. In order to reduce both the effects of interference by and into UWB signals, we propose a new method in conjunction with a multi-carrier type transmission pulse. The results show performance improvement in the presence of strong IEEE 802.11a interference. The proposed method can be used for the coexistence of different wireless systems with UWB system [C203]

## "The Apply of the Expert Systems of Signal Processing with Frequency and Polarizations Characteristics"

This paper is devoted to studying the principles of the system construction of the signal processing with frequency and polarizations descriptions for the complex missions of air traffic control and air supervision. The expedience of consulting model of data processing is considered [C204]

## "Development of a Method of Construction Radar-Tracking Images of the Air Targets"

In article the approach to the decision of a task of formation of authentic bidimensional radar-tracking images in conditions of movement of the flying device on any trajectory with the account of trajectory instability his flight is opened. At formation of images the principle of inverse synthesizing of the aperture is used. The estimation of

efficiency neural recognition of models of the air targets under bidimensional radar-tracking images is carried out [C205]

## "Estimation of the Target Detection Radar Noise Stability at the Ultrawideband Jamming Influence"

The field structure formation of an ultra wideband signal on the input of the target detection radar receiver device with working frequency 1 GHz is considered. The algorithms of the fields temporary structure definition based on the equations Kirghoff-Kothler with the subsequent estimation of the ultra-short impulse accidental jamming power characteristics necessary for specification of accepted signals processing algorithms are offered [C206]

## "Small-Sized Ship Navigating Radar Boosted Accuracy Rating for the Purposes Short-Range Shipping Season"

It is shown, that the modern ship radars of a decimeter and centimetric wave band do not obey safety of float in the constrained and foreshore waters because of poor efficiency of definition accurate parameters and, hence, small information. The use of small duration of an outgoing pulse (about 70 nsec) gives high-resolution capability on range, however does not provide by virtue of lines of causes of high-resolution capability on an azimuth. In the report one of the ways of mastering the accuracy of a radar with the help of use of the "radar-attachment" working in a millimeter wave band is considered. Two types of possible build-up of the antenna systems which can be used in the specified radars of boosted precision that will enable to carry out high-resolution capability on a direction presented [C207]

## "Software for Image Simulation in Ground Penetrating Radar Problems"

The computer program LtSEMPGt simulating GPR profiles that can display the subsurface ground structure consisting of any quantity of objects and layers of any geometrical form and with any electrical parameters, has been developed for wide application. The structure and general characteristics of basic modules of the developed software have been considered. The examples of some calculations have been cited [C208]

## "A Ground Penetrating UWB Radar System"

A new low-cost pulse based ultra-wideband radar system working up to 6.4 GHz has been developed. The main focus was on the use of cheap off the shelf components. Pulse generation in the transmitter was solved with a simple transistor circuitry. In the receiver the down conversion is realized with a sampling phase detector combined with a direct digital synthesizer. To control the radar system and for transmitting the digitized data to the PC a USB-controller is used [C209]

## "Ultrawideband Signal Scattering from a Wirelines Buried in a Ground"

Model of ultra wideband signal scattering from the subsurface wirelines which diameter is small in comparison with length of a sounding wave and depth of its location in ground is considered. The created algorithm allows calculating the signals reflected by a cable which axis is parallel to air-ground interface, at any polarization and direction of an illumination. Results of calculations of ultra wideband signals reflected by cables, located in a lossy, dispersive ground, for various conditions of illumination are demonstrated and discussed [C210]

## "Accurate UWB indoor localization system utilizing time difference of arrival approach"

An accurate ultra wideband (UWB) localization approach has been developed based on time difference of arrival (TDOA). This method provides sub-cm accuracy, which is excellent for indoor utilization when compared with frequency modulated continuous wave (FMCW) systems. The system is also in compliance with FCC UWB regulations and achieves accurate ranging measurements. The utilized time domain measurements suppress multipath signals and have potential for sub-mm resolution [C211]

## "Multiple Window Based Ultrawideband Microwave Imaging for Early-Stage Breast Cancer Detection"

In this paper we propose a multiple window (MW) method for ultrawideband microwave-based breast cancer detection in low signal-to-clutter ratio tissue environments. Multiple space-time beamformers or windows are employed to obtain approximately statistically independent images of backscattered power which are then averaged. Areas of large backscattered power suggest the presence of tumors because of the relatively large dielectric properties contrast between normal and malignant tissue. We develop a criterion for designing the multiple beamformers and illustrate the performance of the MW method with simulated data from a 2-D realistic numerical breast model. We demonstrate that the MW method yields higher signal-to-clutter ratios than the

penalized least-squares based beamformer for various tumor locations [C212]

## "Ultra-wideband and low-profile hybrid EBG/ferrite ground plane for airborne foliage penetrating radar"

High performance airborne foliage penetrating radar requires an antenna design that is low-profile while providing ultra-wideband operation at lower frequencies (100s of MHz) while optimally offering unidirectional radiation. To achieve the desired unidirectional radiation, a ground plane must be implemented that can match the ultra-wideband operation of the antenna being implemented. The needed ground plane must meet these specifications while being low-profile to maintain an overall low-profile antenna design that will efficiently fit in the aircraft. This paper presents a novel ultra-wideband and low-profile hybrid ground plane design that implements ferrite absorbing material with a mushroom structure EBG design. The presented EBG/ferrite hybrid design offers an operational bandwidth exceeding 12:1 starting at 170 MHz [C213]

## "A Closed-Loop Pulsed Power Control Circuit for UWB 24 GHz Automotive Radar Transmitter"

This paper presents a closed-loop power control circuit for a UWB pulse radar transmitter. It provides over 10 dB of dynamic power control on a 24 GHz pulsed signal with pulse width of 1.59 nS and duty cycle of 0.5%. The circuit consists of an on-board directional coupler, a three-stage power detector and an error amplifier. All the circuits are integrated on the same chip with the transmitter in a SiGe HBT process. Temperature compensation schemes are applied to improve the circuits temperature stability. The circuit consumes 2.7 mA current and occupies only 360 times 480 mum2 [C214]

## "The development of a motion-compensated, vehicle mounted, ultrawideband radar for buried landmine detection"

The performance of a vehicle mounted mine detection radar system, developed by QinetiQ, has recently been enhanced by the inclusion of a position and attitude measurement system, using the combination of a differential GPS receiver and an inertial measurement unit. In this paper we present the development of a motion-compensation scheme based upon data from these sensors. Previous to this development, high quality radar images could only be produced from data gathered on relatively flat and even terrain, where uncompensated antenna motion caused by vehicle attitude changes was minimal. However, the new motion compensation scheme has been shown to successfully track the antenna feed positions to within 1 cm accuracy, thus enabling data collection over far more arduous terrain [C215]

## "Sub-10 ps Pulse Generator with Biphase Modulation Function in 0.13-μm InP HEMT"

A next-generation ultra-wideband (UWB) pulse generator with a biphase function is reported. To obtain ultrashort duration pulses, a novel speeding-up AND circuit and biphase modulator circuit were developed. The IC was fabricated in a 0.13-μm-gate InP-HEMT technology, which has a gmof 1520 mS/mm and a fTof 195 GHz. A pulse with a full width at half maximum of 9 ps and a 15-ps biphase modulated pulse were obtained. The power consumption of the ICs were 620 mW and 640 mW, respectively. [C216]

## "Comparison of UWB Target Identification Algorithms for Through-Wall Imaging Applications"

In this paper an ultra-wideband imaging radar system using B-scans is proposed. Two imaging algorithms for shape recognition are explained and compared. Furthermore, for the first time the two dimensional inverse boundary scattering transform was successfully applied for through-wall imaging applications. The measured radar data of a cylinder behind a wall demonstrate that only 24 different positions of the antennas were sufficient to reconstruct the target curvature [C217]

## "Safety assessment of breast cancer detection via ultrawideband microwave radar operating in swept-frequency mode"

Ultrawideband (UWB) microwave radar is a promising modality for detecting early-stage breast cancer. In our current prototype, we synthesize an antenna array by scanning a single antenna to each array position and sequentially transmitting a swept-frequency signal and receiving the backscatter. Our UWB radar operates in the 1-11 GHz frequency band. While it has been assumed that low-power UWB microwave breast cancer detection technology poses no health risk, it is important to formally evaluate the absorption of electromagnetic energy in the breast to establish the safety of such exposure prior to clinical implementation. In this paper, we report the results of finite-difference time-domain (FDTD) investigations of the specific absorption rate (SAR) in 3-D numerical breast models due to microwave radiation in the 1-11 GHz frequency band [C218]

## "A Low-Cost UWB Radar System for Sensing Applications"

A new low-cost pulse based ultra-wideband radar system working up to 6.4 GHz has been developed. The main focus was on the use of cheap off the shelf components. Pulse generation in the transmitter was solved with a simple transistor circuitry. The down conversion in the receiver is realized with a sampling phase detector combined with a direct digital synthesizer. To control the radar system and for transmitting the digitized data to the PC a USB-controller is used [C219]

## "Near Field Imaging for Breast Cancer Detection by UWB Minimum Variance Beamforming"

In this paper, we propose a near field imaging method for breast cancer detection by using coherent-signal-subspace-based wideband minimum variance beamforming. Transmitting the pulse and recording the backscattered signal at 13 antenna positions results in a 13-element array data. The received array data with artifact removal preprocessing is presented as near field model. By extending the coherent subspace method in the far field array processing problem to this near field problem, we develop the near field wideband coherent-signal-subspace-based minimum variance beamforming to construct the image of the breast with tumor embedded. This new method is applied to the computed finite-difference time-domain (FDTD) data to implement the simulation, and the results show that the tumor is clearly identified and localized [C220]

## "Combining Polarimetry with SEM in Radar Backscattering for Target Identification"

In identifying radar targets based on the poles (resonances) in the singularity expansion method (SEM), there is additional information to be gained from the residues. The polarizations of the substructure resonances can also be used as a target signature. In addition, the relative times of arrival of the various resonances at the radar can also be used as another way to construct a target image [C221]

## "UWB Radar RF Front-End to Mitigate Impacts on EESS and Radio Astronomy"

A novel UWB short-range radar (SRR) which effectively mitigates its impacts on radio services using the restricted band such as radio astronomy or Earth Exploring Satellite Service is introduced. The essential components, a burst oscillator generating no carrier leak, and antennas with notch-filtering function are presented in detail. Other key MMICs, such as a high-speed square-law detector, variable gain LNA, a sample-hold circuit, etc. are also described with the performances of the SRR [C222]

## "T- and X-arrangement of "dark eyes" antennas for microwave sensing array"

Ultrawideband radar imaging techniques are currently being studied as a promising tool for breast cancer detection. In this paper, we are proposing two different arrangements of the "dark eyes" antenna for sensing the cross-polarized reflections from the breast. The antenna is planar, compact and the arrangements can be used to form a cross-polarized antenna array. The use of either arrangement should be very promising for polarimetric radar-based imaging of the breast [C223]

## "An Image Stabilization Algorithm for UWB Pulse Radars with Fractional Boundary Scattering Transform"

In this paper, we have proposed an image stabilization algorithm for the fast imaging algorithm SEABED with UWB pulse radars. Although SEABED algorithm can estimate target shapes in a remarkably short time, it has a weakness for noisy data. Therefore, a stabilization procedure is needed to utilize the SEABED algorithm. The proposed stabilization method in this paper is based on a novel transform FIBST which is obtained by expanding the conventional transform IBST. This new transform enables us to deal with the intermediate space between the real space and the data space. In the intermediate space with a suitable parameter, the smoothing hardly degrades the resolution of the estimated image. We analytically derived the optimum parameter for FIBST and developed the stabilization algorithm which can be applied to any target shape. Both stabilization and high-resolution are achieved by the proposed algorithm. The application example showed that the estimation accuracy is improved by 3 times for some cases [C224]

## "Algorithm for the Estimation of Ultrawideband Scattering by a Target for Automotive Applications"

The interest in the development of radar technologies in automotive systems to increase the drivers' safety standard has motivated our research on a simulator to predict the ultrawideband (UWB) scattering by a generic target discretized with a triangular mesh. Radar systems that employ UWB short pulses permit high space resolution and an efficient transmission of electromagnetic energy. This paper presents three different algorithms, i.e. space quantization, planar wavefront, and spherical wavefront algorithms, to predict the field scattered by a

target. In addition to a brief description of the three developed algorithms, a short introduction to the time-domain physical-optics (TDPO) method is provided. Some numerical results are also presented including a comparison of the performances of the three algorithms [C225]

## "A New Procedure for Ultra Wideband Radar Imaging from Sparse Subband Data"

In this paper, we develop a new procedure for estimating the ultra wideband (UWB) radar signatures of targets by using sparse subband measurements. Exemplary results from both simulated and anechoic chamber measured data are presented to demonstrate the usefulness of the proposed technique. [C226]

## "Ultra-broadband Nonlinear Microwave Monolithic Integrated Circuits in SiGe, GaAs and InP"

Analog MMIC circuits with ultra-wideband operation are discussed in view of their frequency limitation and different circuit topologies. Results for designed and fabricated frequency converters in SiGe, GaAs, and InP technologies are presented in the paper. RF type circuit topologies exhibit a flat conversion gain with a 3 dB bandwidth of 10 GHz for SiGe and in excess of 20 GHz for GaAs processes. The concurrent LO-IF isolation is better than -25 dB, without including the improvement due to the combiner circuit. The converter circuits exhibit similar instantaneous bandwidth at IF and RF ports of >7.5 GHz and >10 GHz for SiGe BiCMOS and GaAs MMIC, respectively. Analysis of the frequency behaviour of frequency converting devices is presented for improved mixer design. Millimeter-wave front-end components for advanced microwave imaging and communications purposes have also been demonstrated. Analysis techniques and novel feedback schemes show improvement to the traditional circuit design. Subharmonic mixer measurements at 50 GHz RF signal agree very well with simulations, which manifests the broadband operating properties of these circuits. [C227]

## "Ultra Wideband Wireless Communication on the Base of Noise Technology"

The process of ultra wideband (UWB) data transmission on the base of noise continuous waveforms is considered. The new method of code spectral modulation is proposed for data insertion onto noise continuous carrier. The spectral compression of received ultra wideband waveforms is performed by means of double spectral processing. Experimental results of quadrature correlation measurements in 3.1-4.1 GHz frequency range with successive selection of transmitting data are discussed. [C228]

## "22-29GHz CMOS Pulse Generator for Ultra-Wideband Radar Application"

The pseudo-millimeter-wave ultra-wideband (UWB) is attractive for applications in short-range automotive radar systems using 22 to 29GHz in order to realize road safety and intelligent transportation. Although CMOS is suitable for the short-range radar since processing units can be implemented in the same chip with the UWB front-end building block, it is difficult to operate CMOS pulse generators at such a high frequency. To realize the pseudo-millimeter-wave band using CMOS, the paper have proposed a new pulse generator consisting of a series of delay cells and edge combiners with waveform shaping. As a result of measurement using 90nm CMOS technology, 1Gbps/bit pulses are successfully generated with a power consumption of 1.4mW at a supply voltage of 0.91V. This result is the key technology for a one-chip short-range radar system [C229]

## "Diffraction Waves on a Spherical Resonator Segment"

The application and the generalization of the regularization tasks of the diffraction of electromagnetic waves on a sphere with the circular aperture are proposed. We examine the diffraction of the plane wave, on sphere. We solve auxiliary integral equations of Abel's type and select main parts of functional equations by introducing the small parameters. As a result we obtain disconnected linear algebraic equations of second kind of Fredholm's type. New possibilities of improvement of computational algorithms and different characteristics of spherical antennas (radiation pattern, radiation power, field profiles of different resonant modes, radar cross section, wideband signals) are discussed [C230]

## "The Irregular-Shaped Fractal Antennas for Ultra Wideband Radio Systems"

This paper proposes a novel design of a multiband fractal antenna of irregular shape using two-dimensional fractal clusters. The algorithm of generating fully reproducible fractal clusters is developed. The multiband behavior of the fractal-cluster based antennas is studied by means of numerical analysis. In comparison to regular-shaped fractal antennas more frequency bands and better matching are achieved. The spatial-frequency antenna characteristics are studied under feeding point displacements. As shown by numerical results, small displacements of feeding point allow to control the radiation pattern in certain frequency bands. The larger feeding point displacements are demonstrated to shift antenna frequency bands [C231]

## "UWB Signal Generation, Acquisition and Processing using Wavelet Functions"

Over the past 15 years, extensive research work has been carried out to develop the ultra-wideband (UWB) technology for communication applications, and to resolve the practical challenges in implementing an efficient UWB communication system. In this paper, we present an overview of the application of wavelet functions for UWB communication system. The focus will be on the UWB signal processing. Following a brief review of the characteristics of application specific UWB signal, application of wavelet functions in UWB signal generation, acquisition, and processing will be described [C232]

## "Ultra-wideband Radar Signals Generated with Two-channel"

Synthesis of ultra-wideband (UWB) linear frequency modulated radar signals is a very important technology for microwave imaging, target identification and detection of low radar-cross-section (RCS) targets. In this paper a new method of UWB radar signals generated with two-channel is presented. The realization structure is given, and the principle of signal synthesis is analyzed. At the same time, an automatic adjustment measure of signal phase is proposed because of discontinuity of signal phase in this method. The simulation and experiment results show that radar signals with large instantaneous bandwidth can be generated by means of this method on the condition that the high-speed digital devices are limited [C233]

## "Principles of UWB Multisite Radar Devicesfor Searching Survivors in Rubble"

A combination of prospective ultrawideband (UWB) technology and multisite radar systems (MSRSs) technology is considered for detection and coordinate measurement of motionless survivors in rubble. Main attention is paid to effective detection of weak signals from a moving human chest due to breathing in a background of clutter (intensive reflections from environment) as well as to high accuracy of survivor position determination, especially its angle coordinates. Large signal attenuation and unknown additional delay of signals propagating through rubble are taken into account [C234]

## "Anti-jamming Performance Analysis for Random Noise UWB Imaging Radar"

In this paper, firstly several available jamming models are introduced, and then the evaluation measure of anti-jamming performance for ultra-wideband imaging radar (UWBIR) is followed, finally through the computer simulation, the anti-jamming performance for random noise UWBIR is analyzed and compared with the conventional linear frequency modulation (LFM) UWBIR. The results prove that the anti-jamming performance of the random noise UWBIR shows approximately a 2~10 dB improvement over the linear frequency modulation UWBIR [C235]

## "WLC28-4: An Evaluation of Ultra Wideband Technology for Indoor Ranging"

Ultra wideband technology shows promise for precision ranging due to its fine time resolution to resolve multipath fading and the presence of lower frequencies in the baseband to penetrate walls. While a concerted effort has been conducted in the extensive modeling of the indoor UWB channel in recent years, to our knowledge only two papers have reported ranging performance, but for limited range and fixed bandwidth and center frequency. In principle boosting power can guarantee connectivity between transmitter and receiver, but not precision due to the distorting effects of walls and other objects in the direct path. In order to gauge the limits of UWB ranging, we carry out 5000 measurements up to an unprecedented 45 m in non line-of- sight conditions in four separate buildings with dominant wall material varying from sheet rock to steel. In addition, we report performance for varying bandwidth and center frequency of the system. [C236]

## "A High Repetition Rate Battery-Powered 0.5 MV Pulser for Ultrawideband Radiation"

High power electromagnetic pulses are of importance in a variety of applications such as transient radar, when investigating the effect of strong radio-frequency impulses on electronic systems and modern bio-medical technology. The paper presents details for a compact, battery powered, repetitive pulser, which is capable of producing nanosecond rise-time pulses at voltages exceeding 0.5 MV. The system is based on a Tesla transformer operating in a dual-resonance mode, with a high energy transfer efficiency between the primary and secondary circuits. To obtain a high pulse repetition frequency of at least 1 kHz, the key component is a closing switch in the primary circuit working on the principle of corona stabilization [C237]

## "MIMO Radar Medical Imaging: Self-Interference Mitigation for Breast Tumor Detection"

In this paper, an application of multiple-input multiple-output (MIMO) radar techniques to medical imaging is investigated. MIMO radar, which can be viewed as a form of microwave tomography for medical imaging

geometries, offers an alternative to current X-ray technology. Of particular interest is the detection of cancerous tumors in breast tissue. Previously, ultrawideband radar techniques have been considered. Here, an intermediate bandwidth is assumed, which enables the digitization of the entire baseband signal. However, this comes with the cost of self-interference because of transmitting and receiving simultaneously. Because the scattering response of tumors is weak compared to self-interference, mitigation of the direct transmitter-to-receiver signal is important to detection. In this application, three interference suppression techniques are considered: temporal mitigation, receive-array mitigation, and transmit-waveform optimization. Mitigation residuals, caused by calibration errors and signal nonlinearities, are included in the analysis. A system concept is introduced, and results from simulations using a simplified physical model are presented. [C238]

## "Pulse Amplitude Modulation Direct Sequence Ultra Wideband Sharing Signal for Communication and Radar Systems"

Applying to inter-vehicle communication and satellite communication and location among satellite formation, the sharing signal of integrated systems that applied with ultra wideband (UWB) signal was presented. Pulse amplitude modulation direct sequence ultra wideband (PAM DS UWB) sharing signal model was given, and its power spectrum density was introduced. The ambiguity function of PAM DS UWB sharing signal was derived. From numerical simulations, the PAM DS UWB sharing signal yielded the so-called thumbtack ambiguity function. For practical application, the discussion about estimating communication link and radar range was carried out. The relations among five parameters of the sharing signal were analyzed, too. The results show that the PAM DS UWB signal can be applied to integrated systems. [C239]

## "UWB Signals, SA Perspectives in Radar Guidance"

Now, active or semiactive guidance of antiair missile is commonly implemented using narrowband radar illumination signals. But the usage of wideband signals and inverse aperture synthesis for that purpose can give the new capabilities to the target tracking and missile guidance algorithms. Some simulation results are given in confirmation of that statement [C240]

## "Method of Ultrawideband Linear Antenna Array Matching"

Using a linear waveguide-slot array with one input in the center on the left and on the right as an example, a method of ultra wideband matching a linear array was offered. The use of this method will solve the problem of array design with any number of radiators [C241]

## "Coupling Effects in Resistive UWB Antenna Arrays"

The self- and mutual impedances of elements in the dissipative antenna array are known to involve radiative resistances and loss resistances. This paper is dedicated to analyzing the structure of the mutual impedance between resistive load elements and its effect on the radiation efficiency of the array [C242]

## "The Research of General Aviation ADS-B Base on TD-SCDMA Wide Band Communication Network"

With the development of general aviation, China needs a kind of airborned communication terminal, which is affordable, reliable and convenient. This terminal can broadcast its ranging data periodically which will be received by the aircrafts in the same airspace, so it can realize ADS function. In this paper, based on TD-SCDMA international standard, it introduces two communication modes named "controlled" and "self-organized" used by the airborned terminals. Airborned terminals will realize the wideband data link through the handover flexible between two communication modes and update reserved slots table dynamic. It will assure the safety and regular of ATC through the method in this paper [C243]

## "Pulse-Doppler UWB Radar"

The paper contains measurement results of moving targets by pulse-Doppler UWB radar. The description of a radar, principle of operation and technical specification are presented. Conditions and results of measurements are described. Feature of the presented measurements: Doppler signals of linear moving targets whose linear sizes exceed resolution of radar [C244]

## "Integrated Radar and Communication Based on DS-UWB"

Tremendous efforts have been devoted to develop the UWB technology for radar and communication applications over the past decades. With the rapidly incremental demand, there is something in exploring of

integrated UWB radar and communication system for reducing cost, minimizing the radar cross and probability of intercept, etc. This paper presents an integration system of radar and communication based on direct sequence UWB (DS-UWB). It utilizes different PN code to spread the spectrum of radar and communication data to avoid jamming mutually. The simulation over an ideal AWGN channel shows that the system can work perfectly [C245]

## "2D Imaging Algorithm for the Evaluation of UWB B-Scans"

This paper proposes an ultra-wideband imaging radar system using B-scans for the target identification. The two dimensional inverse boundary scattering transform was successfully applied for through-wall imaging applications. Using this algorithm it is not only possible to detect the target but also to reconstruct the surface curvature of a cylinder behind a wall. Moreover, it is shown that only 24 different positions of the antennas are sufficient to estimate the target shape which results in a low computation time [C246]

## "On Transient Radiation of a Linear Impedance Antenna Exited by the Electron Bunch"

A linear impedance antenna of transient radiation exited by the electron bunch scattered on its end face is considered. The radiation is analyzed at the stage of a bunch approach to the antenna. The radiation is an induced or diffraction one and has a nature of forced oscillations. The radiation spectrum has an extremum. The dispersion equation of an antenna is derived. The expressions for the components of the discrete spectrum of the current force and the strengths of electric and magnetic fields, radiated by the antenna, are constructed as a series in the antenna eigen functions. It is shown, that the antenna element is radiative if the strengths of extrinsic and intrinsic electric fields are in phase and in antiphase accordingly to the antenna current. In this case the extrinsic electric field strength accelerates the conductivity electrons and the intrinsic electric field strength brakes electrons, producing the radiation of latter ones [C247]

## "Subsurface illumination and propagation in Ground Penetrating Radar"

It is desirable for ground penetrating radars to accurately determine positions of buried objects. This paper uses a combination of a ray-tracing technique and the finite difference time domain technique to assess the performance of a novel deployment strategy for ground penetrating radar where the transmitter is placed in an available structure underground. Promising characteristics are seen offering operation of the radar with lower dynamic range and higher bandwidths. The deployment system also appears to offer satisfactory illumination over a relatively large area. [C248]

## "Ultrawideband array antennas for radars"

The paper presents the results of investigations of array antennas intended to radiate high-power pulses of nanosecond and subnanosecond length. The array element is a combined antenna optimized for a given length of the exciting voltage pulse. Linear array antennas were investigated by the radiation wave beam in the steering mode. Possibility to form dual-polarization wave beams owing to the plane array antenna dividing into two sub-arrays and their excitation by the time-shifted voltage pulses was shown. Parameters of high-power radiation sources based on array antenna excitation by bipolar voltage pulses are presented. [C249]

## "Qualitative Analysis of Elementary Antennas Impulse Radiation"

The aim of this paper is to study the non-stationary structure of simple antenna fields (the electric dipole, the vibrator, the system of dipoles) with the help of the qualitative theory methods for the ordinary differential equations (ODE). The qualitative analysis is of interest because numerical research meets the certain difficulties in vicinities of the vector field critical points, and qualitative methods are effective in these cases in particular. Therefore the combination of qualitative and numerical methods is the most expedient and economical approach in the analysis of electromagnetic fields. The strategy of qualitative theory application to the analysis of pulse fields of simple antennas in free space, and also the results in this area received to the present time are discussed [C250]

## "Widening UWB System Coverage Zone by Repeaters-Regenerators"

The Federal Communications Commission (FCC) of the USA has limited communication coverage zone for pulse UWB systems by implementing power density mask on all transmitting devices. As result the UWB coverage area is not exceed a hundred meters. But it is possible to increase this area, still fulfilling the FCC limits, by adding one or more UWB repeaters around or along the path toward a destination receiver(s). The paper deals with the idea of such repeaters-regenerators and their implementations [C251]

## "Towards radar-enabled sensor networks"

Ultra wideband radar-enabled wireless sensor networks have the potential to address key detection and classification requirements common to many surveillance and tracking applications. However, traditional radar signal processing techniques are mismatched with the limited computational and storage resources available on typical sensor nodes. The mismatch is exacerbated in noisy, cluttered environments or when the signals have corrupted spectra. To explore the compatibility of ultra wideband radar and mote-class sensor nodes, we designed and built a new platform called the radar mote. An early prototype of this platform was used to detect, classify, and track people and vehicles moving through an outdoor sensor network deployment. This paper describes the sensor's theory of operation, discusses the design and implementation of the radar mote, and presents sample signal waveforms of people, vehicles, noise, and clutter. We demonstrate that radar sensors can be successfully integrated with mote-class devices and imbue them with an extraordinarily useful sensing modality [C252]

## "Impulse Formation by Spatial-Time Phase Encoding"

This paper comprises of the analysis of basic properties of the spatial-time signal upon emission of the phase-shift keyed signal by each element of the active phased antenna array. Mathematical modeling results are presented in terms of the phase-shift/code-shift keyed (FKM) signals with random even phase distribution [C253]

## "Compact UWB tapered-CPW-fed planar monopole antenna"

A planar tapered-CPW-fed monopole antenna, consisting of a circular patch and a trapeziform ground plane, is introduced. Both circular patch and ground plane are printed on the same side of a thin substrate, therefore the antenna can be easily fabricated with low cost, and achieve an extremely wide impedance bandwidth because of the tapered CPW feeder and trapeziform ground plane. The experimental results demonstrate that the antenna obtains a VSWR≤2 bandwidth of 9.2:1, covering frequency range from 0.97 GHz to 8.98 GHz, which is suitable for applications in UWB communications and radars. [C254]

## "Ultra wideband reconfigurable beam forming and beam shaping for radar and electronic warfare applications"

Ultra wideband reconfigurable beam forming, and in particular aspects of using frequency dependent aperture area, are discussed. A schematic beam former is proposed, and two key MMIC components, a reconfigurable power splitter/combiner and a 9-bits time delay, are presented. [C255]

## "A new UWB antenna with excellent time domain characteristics"

Description and performance of a novel physically small UWB omnidirectional antenna are presented. Greater than an octave frequency bandwidth and very short antenna ringing time have been demonstrated. The antenna is relatively immune to close-in environmental perturbations. Behaviour of a unidirectional variant of the antenna is also presented. [C256]

## "Cylindrical array beamforming based on ultra-wideband signals"

Conformal array antennas are very attractive for many applications interest, especially in space-born radar, navigation, and radio communications, where the allowable space for antenna platform is very limited. One type of conformal array antennas is the cylindrical array which can provide wide angular coverage in both the azimuth plane as well as the elevation plane. In this paper, the principle of cylindrical array beamforming based on ultra-wideband impulse (UWBI) waveforms is introduced. Antenna patterns, such as amplitude pattern and energy pattern, are derived for the cylindrical array as functions of array dimensions and signal bandwidth. [C257]

## "Bistatic ultra-wideband SAR for imaging of ground targets under foliage"

Bistatic SAR is compared with monostatic SAR concerning, e.g. coherent integration time and spatial resolution. We also suggest that bistatic SAR may be used to suppress background clutter, e.g. when the clutter scattering is dominated by dihedral or trihedral scattering mechanisms. This idea is applied to the problem of detecting concealed vehicles in foliage using VHF-band SAR. Electromagnetic simulations show that the vehicle-to-clutter ratio can dramatically increase by choosing different incidence angles for the transmitter and receiver in a bistatic SAR. [C258]

## "Interference Rejection in UWB Radio System Using Adaptive Transversal Filter"

In this paper we consider a UWB radio system performance using pulse position modulation in the presence of

various types of interferences. Interference rejection using adaptive transversal filter, as well as the range of the interference rate where the use of the filter is required, is considered in this paper [C259]

## "Ultrawideband multisite radar systems: peculiarities of target detection, resolution and coordinate measurement"

Because target radial dimensions are, as a rule, much larger than a range resolution cell of ultrawideband (UWB) radars, each radar receives the so called "range profile" of a target. Target detection, resolution and coordinate measurement of such targets significantly differ from the corresponding procedures for narrowband multisite radar systems (MSRSs) and have not been sufficiently discussed in known literature. These important peculiarities are considered. Noticeable advantages of UWB MSRSs have been shown when range profiles of a target may be expected to be equal with respect to all radars [C260]

## "Wideband and Multi-Band Antennas and Arrays"

{no data available} [C261]

## "Signal processing method for detection of subsurface objects by ultra-wideband SAR"

The problem of subsurface target detection has been studied. Modifications of a damped exponential model has been applied for reducing the clutter due to a rough boundary. Utilizing numerical simulations, a sensitivity analysis is performed to investigate the features of detection of low-contrast targets. The dependence of the received signal on the properties of an inhomogeneous medium, rough surface and the locations of the objects has been studied. The calculations have been performed for randomly buried objects. It has been found that it is possible to significantly improve the ratio between the scattered signal from subsurface objects and the scattering from a rough boundary. [C262]

## "Hand-held operational demining system"

The paper presents selected results from theoretical and experimental investigations concerned with radar backscattering from typical antipersonnel land mines (APL) in the frequency range of about 200 MHz to 8 GHz in order to improve the conventional metal detector demining technology presently still widely in use. [C263]

## "Ultra wideband multiple-input multiple-output radar"

The utilization of ultra wideband (UWB) signals enables the radar designer to solve the most important problems of radar target observation. The extremely wide bandwidth enables greater information to be obtained due to high time resolution and the frequency dependence of the scattering centers over this large bandwidth. Increase in the radar's signal bandwidth can improve radar performance by providing better range measurement accuracy, improving the target identification and tracking capability, improving radar immunity to passive interference, and enhancing radar countermeasure against narrowband electromagnetic signal interference. Recently there have been many advances in multiple-input multiple-output (MIMO) antenna systems in communications. These diversity systems have been shown to have the potential to dramatically improve the performance of the communications systems. Unlike the traditional beamforming approach, which uses highly correlated signals of an array of transmitting or receiving antenna elements to collimate a beam towards a certain direction in space, MIMO capitalizes on the independence between signals from different transmitters and on the diversity of target scattering to improve the information received from the response, Motivated by the advances and benefits of MIMO in communications and advantages of using UWB signals, this paper presents the experimental investigation of UWB-MIMO radars. The analysis of such radars has been carried out to demonstrate its promising features in terms of better target identification and improved signal to noise ratio (SNR). [C264]

## "UWB sampler for wireless communications and radar"

An ultra wideband (UWB) sampler, realized using step recovery and Schottky diodes on coplanar waveguide, coplanar strips and slotlines, has been developed for UWB wireless communications and radar systems. The impulse generator, providing signal for the sampling gate, was also included along with a new LO feeding structure. The fabricated circuit shows 16-19 dB conversion loss without amplifier and 1-4 dB conversion gain with amplifier across a 9-GHz RF bandwidth with 500-MHz sampling frequency. [C265]

## "Design and realization of a compact, low-cost, ultra wideband ground penetrating radar system"

The ground penetrating radar (GPR) is currently one of the most convenient sensors used for the detection of the dielectric objects buried under the ground. Ultra wideband (UWB) GPR has a significant advantage due to

benefit from both low and high frequencies, which means long-range detection with better resolution respectively. In this paper, a compact, low cost GPR using an impulse waveform is developed. The UWB GPR system is mainly composed of an impulse generator, UWB transmitting and receiving antennas, timing circuit, signal conditioner, high accuracy digitizer, and a laptop computer for data storage and image processing. An experimental UWB GPR system is designed and tested. [C266]

## "Coexistence study on ultra-wideband and mobile cellular systems"

This paper presents the results of a series of laboratory and field measurements conducted for the co-existence study on ultra-wideband (UWB) and mobile cellular systems. In these studies, we introduced UWB interference to the GSM/GPRS and IMT-DS handsets in two circumstances, firstly in the lab under controlled conditions, and subsequently in the field using commercial GSM and pre-commercial IMT-DS networks. In the laboratory, we determined how the BER (for GSM) or BLER (for GPRS) of the radio downlink varies with the C/IUWBratio for 30 different impulse-based UWB signal types. Measurement results obtained in the laboratory showed that a C/IUWBratio of 11 dB and 10 dB should be used as the condition of coexistence between a UWB device and a GSM (1800 MHz) handset, and between a UWB device and a GPRS (1800 MHz) handset respectively. For IMT-DS, results obtained using voice and data services showed that all the threshold EIRP values (for different UWB signal types used) are higher than the level currently permitted by the FCC's emission mask for handheld UWB systems i.e. -63.3 dBm/MHz for 1610-1900 MHz band and -61.3 dBm/MHz for 1 990-3 100 MHz band. This study also validates the assumption that UWB power adds up in a simple linear manner. [C267]

## "Multistatic radar with ultra-wideband pulses: FDTD simulation"

A simulation of a multistatic radar using the finite-difference time-domain method is performed to identify the presence of an intruder inside a residence. The radar operates with ultra-wideband pulses to obtain high resolution. One transmitter and three receivers, positioned outside the residence, are used to estimate the location of an intruder inside the residence without ambiguity. [C268]

## "Nanoantennas: A concept for efficient electrically small UWB devices"

This paper introduces the concept of a "nanoantenna:" a device that radiates UWB impulses from the discharge of a conducting enclosure antenna. By trapping exterior electrostatic energy, a nanoantenna has the potential to radiate energy more efficiently than generally believed possible, enabling efficient millimeter scale 3.1-10.6 GHz UWB devices. [C269]

## "Numerical study of wide-band low-grazing HF clutter from ocean-like surfaces"

Backscattering of a vertically polarized, ultra-wide band HF pulse (3-30 MHz) from one-dimensional Pierson-Moskowitz impedance surfaces is studied using method of moments (MoM)-based numerical simulations. With the field source located near the surface, low-gazing regime is realized for the most of the illuminated region. The direct numerical solution is compared to approximate calculations based on the small perturbation method (SPM). Once the Norton surface wave effects are included in the SPM scattering coefficient, average clutter levels as well as waveform shapes generally show good agreement. As the sea state increases, backscatter returns from farther ranges exhibit larger discrepancies. In such a situation, using the "effective surface impedance" (that accounts for surface roughness) brings SPM-based average clutter levels in agreement with their MoM counterparts: however, the differences in waveform shapes persist. Future studies will use the simulation capability described in this paper to investigate the ability of a short-pulse, ultrawideband HF radar to image ocean waves, measure surface currents and surface current shear, and detect targets. [C270]

## "A proposed peak power measurement system"

Ultra-wideband (UWB) is an emerging radio communication technology [RD Wilson et al] that uses fast rise time pulses to convey information or provide radar-like images. Commercial UWB devices spread the signal over very large bandwidth, have mostly pulsed emission, and operate at very low power. Thus UWB represents new challenges in the way radio frequency measurements are made for conventional radio communication systems. This document describes a method which measures peak power exceeding the resolution bandwidth of conventional spectrum analyzers. First, it pointed out the matters on spectrum analyzer measurements, and then an instrument which combines a spectrum analyzer with an oscilloscope is proposed to measure on wider resolution than conventional method. [C271]

## "Applications (communication, radar, GPR, medicine)"

First Page of the Article [C272]

## "The solving of ecological monitoring task with microwave"

Microwave technique and device for the measurements of refraction coefficients in different layers pollution of atmosphere surface near the plant with phase radar methods are presented. Uncertainty elimination of the phase measurements is discussed and one is achieved by frequency changing upon certain rule. That gives increasing of measurement accuracy. [C273]

## "A UWB impulse surface penetrating radar system for pavement evaluation"

An advanced UWB impulse surface penetrating radar (SPR) system-RadarEye is introduced in This work. It provides high resolution pavement thickness estimation and subsurface objects imaging for civil structures inspection. Super resolution time delay estimation algorithm based on wavelet transform and TAM-BP imaging algorithm are presented with high accuracy on layer thickness estimation and high spatial resolution on subsurface imaging. Both indoor and outdoor experiments show the feasibility of this system. [C274]

## "Natural resonance frequency extraction using an early-time and late-time responses combined technique"

In this paper, a pole extraction method using an early-time and late-time responses combined technique is presented. Without the determination of the beginning of the target transient response, the proposed method assumes an ARMA representation to approximate the complete target transient response, and a total least square method is applied to poles extraction. The proposed method is validated using a measured scattering data of a thin wire and a finite cylinder. The processing results show that the proposed method is superior to the KT method and matrix pencil method in an appropriate SNR [C275]

## "Comparative analysis of the narrowband and wideband methods of target recognition"

Results of comparative study of radar recognition with the use of narrowband and wideband signals as well as various recognition signatures are presented. The advantage of wideband radar signals is emphasized. The results show that use of wideband signals allow increasing the accuracy of radar measurements and radar immunity against interference providing the same detection range. [C276]

## "Scattering pulse signal on layer-uniform half-space"

The problem of a plane pulse wave scattering of on the layer-uniform half-space with arbitrary complex dielectric permittivities of layers is considered. The proposal method bases on the boundary problem solution for the system of stationary Maxwell equations and well adapted to determination of complex amplitudes of the fields at any point of space. [C277]

## "Signal processing techniques at radar measurement of the UWB polarization characteristics"

In the report the principles of processing of the UWB signals for an estimation of frequency responses polarization matrices by results of measurements are discussed. The reviewed methods are introduced in a "TSUNAMI-3" collimating type radar measuring complex. The outcomes of obtaining 2D polarization object radar images on experimental data are resulted. [C278]

## "The electromagnetic compatibility of rass techniques under the airfield conditions"

The solution of the electromagnetic compatibility problem for radioacoustic atmospheric sounding equipment in the airfield conditions by using a special quasicontinuous condition is discussed. Namely, the sounding acoustic parcels are illuminated with radio impulses of a triangular pulse envelope form, and the spatial fronts duration providing the coverage of the whole working height interval. In the sounding height interval of about 500 m, the active spectrum-width of radiated radio signals is only 0.34 MHz, i.e. approximately five times less than that of short rectangular radio pulses. The sounding height measurement is made via acoustic channel with the margin error not worse than 0.8 %, the sound pulse parcels spatial duration is 30 m. Such radioacoustic techniques can be placed in immediate proximity to a runway in order to control mesoscale weather phenomena, dangerous for aircraft. [C279]

## "The analysis of the matching opportunity of the parameters of the wideband through ionosphere signals with real dispersion radio line"

Concept of active mastering and constructive use of dispersive deforming properties of the transmitting

environment which are limiting accuracy, carrying and resolution of broadband radio-electronic systems, for example, communication, location, navigation (including global) are first worked out in This work. [C280]

## "Recognition of objects on their complex natural resonance at ultra wideband sounding"

In this report, the RSO (radar subsurface objects) complex resonance frequencies are used as features of their recognition proposed. From these features the basis of the prior information about identifiable object scattering characteristics is described. However, for practical implementation of described algorithm of RSO recognition it is necessary to explore and to take into account effect of some complicating factors such as deformation of observed data. Thus from this report the algorithm of recognition of RSO is designed. [C281]

## "Based on two-port network theory simulation of electromagnetic wave propagation in multilayer medium"

The simulation program for analysis of impulse electromagnetic wave propagation in multilayer medium providing to take into account the frequency dependence of electrophysical parameters of layers (dispersion) was developed based on two-port network theory. [C282]

## "Algorithm of signal processing in ultra-wideband radar designed for remote measuring parameters of patient's cardiac activity"

The algorithm of processing the data received from the medical ultra-wideband (UWB) radar is described. The algorithm provides a possible of comparing the results of heart activity monitoring performed by the UWB radar with indications from the electrocardiograph and making a conclusion about the opportunity of using the similar equipment in medical institutions. [C283]

## "Some aspects of usage of the pseudo noise sequences in the radiolocation systems"

Pseudo noise sequences (Barker's codes, M sequences etc.) widely use in communication and navigation systems. But for nowadays this kind of signals almost has no application in the radiolocation systems. This work investigates aspects of usage of pseudo noise sequences (PNS) in the radiolocation systems, some aspects of generating and processing of the input processes. Main emphasis was made on signal-to-noise ratio behaviour in the systems with pseudonoise signals in comparison with classic radiolocators. [C284]

## "An experimental UWB module-based sensing and communication system"

An experimental UWB system is developed, designed, prototyped and tested to support a number of multitask sensing and telecommunication applications in the 0.1-3.0 GHz band, viz. subsurface radar or GPR, intrusion sensor, "trough-wall seeing" scanner, indoor comm. & geolocation and so on. As such, a set of hardware modules has to be created that can be combined/assembled in a particular fashion/architecture for each specific mission including functioning with receiving and transmitting UWB arrays (a part of our ongoing R&D efforts). The basic system components involve: (1) transmitter (Tx), (2) receiver (Rx), (4) antennas, (5) control unit, (6) digitizer and comp interface. As well, controlling and processing software is an inherent part of each such system that has to be configured for each specific operational task [C285]

## "Nonperiodical wideband signals in synthetic aperture radar"

In the synthetic aperture radars periodical signals (usually radiopulses with the rectangular envelope) are used. This leads to ambiguity measurements which must be eliminated by varying different parameters of the SAR. In this paper we consider usage of the nonperiodical signals to avoid ambiguity measurements in synthetic aperture radars. Examples of the processing algorithm simplification are represented [C286]

## "The automatic determination of soil permittivity using the response from a subsurface local object"

The method for determining permittivity of soil containing a local object is proposed. The method based on the Hough transform is one of effective means to detect hyperbolic reflections from such objects on the GPR profile image. On the basis of the same method the iterative algorithm, which allows automatic determination of exact value of permittivity of ground using the results of subsurface radiolocation, has been developed. Its efficiency is shown using the simulated GPR profile example. [C287]

## "Advantages of the wideband and ultra wideband signals in the remote sensing"

Some aspects of the wideband and ultrawideband signals usage considered. Essential aspects of the processing

techniques as well as models of the input process represented and discussed. The term efficiency bandwidth and principle of the waveform selection represented. Concept of the wideband signals in the synthetic aperture radar presented. Results which show advantages of these signals are shown. [C288]

## "UWB radar high resolution ISAR imaging"

Are presented results of high-resolution ISAR imaging using ultra wide band radar system working in time domain. Experiment was done in the ordinary room. Image resolution was 1 mm. Results are important for various applications. [C289]

## "Ultra-wideband radar"

Here, we present a description of a block scheme, characteristics, specific features of design and results of testing for a prototype of the ultrawideband (UWB) radar, which has been developed by Russian UWB group researchers at Moscow Aviation Institute at "analog and digital radio systems" department (www.uwbgroup.ru). The prototype was designed within a research work, which we are conducting on the state order from one of Russian federation state institutions. The UWB radar is intended for detection of moving targets at a distance of several kilometers. The radar design is divided into two stages. In the first stage, we have produced a radar prototype, which incorporates a low power narrow-pulse generator (NPG). During laboratory test, the prototype has afforded the detection of moving targets at the distance of up to one hundred meters. Thereby, the validity of technical solutions used for the whole radar's and radar unit's design was confirmed. In the second stage, we plan to conduct field tests of the radar prototype equipped with a high power NPG. [C290]

## "Signal processing in UWB radars of small distance"

In the paper, the methods of signal processing with reference to ultrawide band (UWB) radars designed for detection and remote measuring parameters of moving objects at short ranges (tens of centimeters-several meters) are considered. It is shown that the relative changes of an oscillation frequency filling an outgoing pulse and duration of these pulses originating at reflection from a moving target are very small; that makes impossible their practical measurement. Therefore, for detection of signals reflected from a moving target the phase method is chosen. [C291]

## "Ultrawideband radar for remote detection and measurement of parameters of the moving objects on small range"

Consideration is given to methods of designing ultrawide band (UWB) radars intended for detection and remote measuring parameters of moving objects at short distances (tens of centimeters-units of meters). The descriptions of radar's structure schemes and characteristics are given together with main results of prototype test. The analysis of fields of application for UWB radars demonstrates that radars of that type can be used practically in all cases where we need highly precise remote observation of moving objects at short distances. [C292]

## "Application of the audio interface for ground penetrating radar data representation and interpretation"

The present article offers a description of software complex, which supports reception and preliminary processing of ground penetrating radar (GPR) information, development of flag description, generation of radar displays and synthesis of their audio representation in the tasks of underground sounding data interpretation. A method of image-to-sound conversion is described, with the storage of image information at the level of attainable resolution. Technical feasibility of the replacement of visual perception with acoustic perception has been substantiated. Practical limitations of the parameters of conversion have been defined, and the conformity of the coded values with the level of perception of audio information has been verified. [C293]

## "The use of the monopulse type antenna system in GPR for increasing accuracy of horizontal coordinate measurement"

The possibility to increase accuracy of horizontal coordinate measurement of the local near surface object by means of using the monopulse type antenna system is presented. The basic principles of designing such an antenna are discussed. It is shown that if the receiving (or transmitting) unit is placed in the center of the antenna system there is a possibility to form in the symmetry plane an electromagnetic field with zero amplitude or absence of signal reflected from the object located in the symmetry plane owing to symmetry of antenna system and inverse driving of the antenna elements. It is proposed to use this phenomenon to increase accuracy of GPR measurements. Experimental GPR data illustrate high contrast of radar image of the object if these data

are acquired by GPR with monopulse type antenna system. Such a design of the antenna system provides high electrodynamic isolation between the transmitting and receiving units of antenna system [C294]

## "Simulation of target detection using a high range resolution radar"

The use of wideband radar signals is sometimes more preferable for solving not only the tasks of target resolution, recognition, measurement, and the illumination stealth, but the traditional task of detection too. The latter is due to the decreased fluctuations of echoes. However, if the signal has an excessively wide bandwidth, the losses of noncoherent integration increase and the threshold signals rise. We investigate the detection threshold signals for the targets of different sizes, for illumination signals of various bandwidths, and for detection of different type. [C295]

## "Non-invasive respiratory movement detection and monitoring of hidden humans using ultra wideband pulse radar"

In this paper a novel method for vital parameter detection using an ultra wideband (UWB) pulse radar is presented. By using sub-nanosecond pulses the displacement of a human chest due to respiratory movement can be detected very accurately. Because of the very broadband behavior of the transmit signal the presented system is also capable of penetrating materials like walls. For signal processing we use the continuous wavelet transform (CWT) with a special background subtraction method. This allows a detection of respiration up to a distance of 5 meters and also behind walls. The radar test set-up with the used components and the applied signal processing on real measurement data are presented. [C296]

## "Frequency hopping ultra wideband inter-vehicle radar system using chirp waveforms"

In this paper we propose a inter-vehicle UWB ranging system using chirp waveforms instead of the conventional UWB-IR ranging system that uses modulated Gaussian pulses. In the proposed system, the transmitted signal consists of a linear combination of chirp signals with the same time duration but different frequency bands. It is assumed that the channel model of the inter-vehicle communication system is a two-path channel model. The proposed system and conventional UWB-IR ranging system is evaluated in such a two-path channel model. The proposed system achieves better performance. [C297]

## "Estimation of radar target reflectivity in ultrawideband regime-a group theoretic approach"

The paper presents a fundamentally new mathematical framework based on group representation theory for the modeling and processing of signals in the ultrawideband (UWB) regime. A group theoretical approach is motivated by the fact that in the UWB regime, the underlying mathematical structure of the inverse scattering is governed by the affine group. In particular, a received echo can be viewed as the affine Fourier transform of the range-Doppler image evaluated at the transmitted waveform. Based on group representation theory and a novel Wiener filtering method over the affine group, we derive a regularized closed form analytical estimate of the range-Doppler target reflectivity density in the presence of nonstationary noise and clutter in the UWB regime. This estimate also leads to a method of data fusion to form synthetic UWB high resolution images from multiple radars with narrowband transmission. [C298]

## "3-D broadband ground-based polarimetric SAR data processing for the monitoring of vegetation growth variations"

SAR is usually used for airborne or space borne remote sensing. It can also advantageously be exploited in a ground-based radar imaging system named Ground-based SAR (GB-SAR). We extended earlier approaches and developed an ultrawideband, ground-based, fully polarimetric SAR (Pol-GB-SAR) system for the monitoring of vegetation growth variations. Measurements on three type trees in different conditions were carried out by the developed SAR system. We proposed effective 3D broadband Pol-GB-SAR data processing algorithms in the paper. In situ polarimetric calibration obviously improved the features of the system. 3D images were reconstructed from the acquired data by a series of signal processing procedures based on a variety of wave equation migration methods. By implementing methods of radar polarimetry, the broadband GB-SAR system has possibility for monitoring changes in tree structure characteristics due to seasonal variations. Interpreted results demonstrated the target scattering characteristics in different vegetation growth situations showed good agreement with the ground truth [C299]

## "Optimal pulse penetration in Rocard-Powles-Debye model dielectrics using the Brillouin precursor"

When an ultrawideband electromagnetic pulse penetrates into a causally dispersive dielectric, the interrelated effects of phase dispersion and frequency dependent attenuation alter the pulse in a fundamental way that

results in the appearance of precursor fields. For a dielectric described by the Rocard-Powles extension of the Debye model, the dynamical field evolution is dominated by the Brillouin precursor as the propagation depth typically exceeds a single penetration depth evaluated at the carrier frequency of the input pulse. This is because the peak amplitude in the Brillouin precursor decays only as the square root of the inverse of the propagation distance. Because of its unique nonexponential peak decay, the Brillouin precursor has direct application to foliage and ground penetrating radar, remote sensing and wireless communications in adverse environments. Of equal importance is the frequency structure of the Brillouin precursor which exhibits a complicated dependence on both the material dispersion and the input pulse characteristics. A Brillouin pulse is then defined and shown to possess near optimal (if not indeed optimal) material penetration. [C300]

## "Technology development of short range ultrawide-band radar system"

Ultrawide-band (UWB) short-range radars (SRRs) are one of the attractive applications for UWB systems. Considerations of both automotive SRR applications and their physical layer design for the system using the 24 GHz-band is introduced. The status of our development as a collaboration research project at Yokosuka Research Park is also described. [C301]

## "2004 International Workshop on Ultra Wideband Systems Joint with Conference on Ultra Wideband Systems and Technologies. Joint UWBST & IWUWBS 2004 (IEEE Cat. No.04EX812)"

{no data available} [C302]

## "A differential sub-nanosecond high-isolation absorptive active SiGe 24 GHz switch for UWB applications"

This paper presents the design and measurement of a SiGe sub-nanosecond, high isolation, single-pole double-throw (SPDT) and single-pole single-throw (SPST) differential absorptive active switch at 24 GHz for ultrawideband (UWB) applications. The switch and digital driver consume 24 mA from a 5 V supply. The active area of the SPDT and SPST is 1000 μm Ч 550 μm and 670 μm Ч 340 μm respectively. The novel circuit topology implements a SPDT that inherently maintains the port impedances regardless of the state of the switch. The insertion loss is less than 3 dB over the 20-26 GHz range and the isolation is >42 dB at 10-30 GHz with a switching time of 100 ps. [C303]

## "UWB developments within Task Group 1/8 of the ITU-R"

Ultra-wideband (UWB) is a wireless technology that can operate at very low-power to communicate high data rates over short distances. UWB can be integrated into various applications such as short-range communication systems, vehicular radar systems, and radar imaging systems. The International Telecommunications Union, Radiocommunications Sector, (ITU-R) created Task Group 1/8 to address UWB compatibility with radiocommunication systems. The paper presents regulatory challenges relevant to the introduction of UWB systems and describes UWB developments within the ITU-R Task Group 1/8. [C304]

## "Theoretical limit on two dimensional generalized complementary orthogonal sequence set with zero correlation zone in ultra wideband communications"

The application of two dimensional (2D) complementary sequences in ultra wideband (UWB) communication systems has brought a new opportunity for such systems' development. To binary, ternary or polyphase two-dimensional sequence sets, the concept of 2D complementary sequences is generalized to a 2D generalized complementary orthogonal sequence set (GCOSS) with zero correlation zone (ZCZ); a novel lower bound for such a sequence set is derived and presented. [C305]

## "Generators, antennas and registrator for UWB radar application"

The paper describes the basic elements developed for realization of UWB radar: generators, antennas and registrator. Generators produce UWB signals of nano- and picosecond duration, having the form of a step-like function, a monopulse, or a pulse in the form of sine wave single period (monocycle). Fulfillment of FCC radiation requirements means filtering the UWB signal spectrum, which results in distortions of the waveform. It is shown that filtering sine wave single period pulses of 0.2 ns duration provides slight distortion. A description of a TEM broadband shielded horn antenna with low side and back pattern lobes is given. The registrator for reception of UWB signals and software for secondary signal processing are described. [C306]

## "Experimental investigation of radar backscatter from plunging breakers using an ultrawideband

radar and visible/infrared cameras"

Interim results of a laboratory investigation of the low-grazing angle radar backscatter generated by plunging breakers are presented. A primary objective of this investigation is to experimentally verify a scattering mechanism through which the horizontally-polarized backscatter generated by the breaker can exceed that at vertical polarization, without involving multipath propagation between the front face of the wave and its crest. The experiments were conducted at the University of Maryland-College Park wave tank, and involved the deployment of a dual-polarized, ultrawideband radar, multiple high-speed visible cameras, and an ultra-sensitive infrared camera. All instruments were deployed simultaneously on a moving carriage, located above the wave tank channel, that followed the breakers as they evolved in space and time. Representative ultrawideband radar data and optical images are presented in this paper [C307]

## "Wideband radar (advantages and problems)"

Review of advantages and problems of wideband radar is given. Some criteria of wideband (UWB) radar are discussed to avoid misunderstanding when only the relative signal bandwidth is used as a criterion. Brief historical outline of the first and follow up experiments by different authors is presented. Advantages and disadvantages of bandwidth widening can be compared using the computer simulation of scattering. Experience of various simulation methods use, their applications to the target detection, tracking and recognition problems are briefly discussed and compared with experiment. Interference immunity, electromagnetic compatibility, stealth of radiation (low probability of intercept- LPI) for radar, and the possibility of creation of antiLPI passive radar are also discussed. [C308]

## "A novel ultra-wideband offset-fed reflector antenna system with main lobe selection"

We present results of research, development and tests of a novel ultra-wideband offset-fed reflector antenna system with main lobe selection for ultra-wideband radars with high resolution. [C309]

## "Neural recognition of aerial target types using a high range resolution radar"

The combination of the least mean squares and back propagation training procedures for the ANN training is considered on the example task of recognition between 11 types of aerial objects using a high range resolution radar (HRR radar) allowing to obtain single range profiles (RP) or trains of RPs. Results of simulation are presented. [C310]

## "Radar images of the covered trenches FDTD simulation"

Results of computer simulation of the video pulse electromagnetic wave scattering in the media containing a dielectric insertion of rectangular or trapezoidal form imitating the backfilled trenches are presented. The finite difference time domain (FDTD) method and the second-order Mur absorbing boundary condition are used for the task solving. Radar images of rectangular form trenches have been analyzed in dependence on depth and width of the trench and on the spacing between the sounding field source and observation point (in other words on the separation between the transmitting and receiving antennas of the GPR). It is ascertained common properties, typical for the radar images of all type of trenches and individual properties typical only for the trenches either, one or another type. It is investigated distinctions of the radar images. [C311]

## "About the possibility of increasing of noise defended radio-wave radar at application of the "short" signal"

The purpose of the article is the decision of a problem of increasing of quality characteristic radio-wave radar. The method of the "short" signal is given. One of ways of increasing of quality indicators radio-wave radar is increasing energy potential of radio-wave radar: 1) increasing potential of a probing signal; 2) increasing radars length. [C312]

## "Problems and promising lines of development of UWB ground penetrating radiolocation"

Some problems existing in modern UWB ground penetrating radiolocation are analyzed. Possible ways of further development of GPR engineering are discussed. Approaches to a problem of primary radar data improvement are proposed. [C313]

## "High-resolution radars at the Institute of radio astronomy of the NAS of Ukraine"

A review is given of recent activities undertaken in the Institute of radio astronomy of the National academy of sciences of Ukraine for the development of high-resolution radars. The radars developed include 95 and 36 GHz

cloud radars and an airborne, Ku-band SAR radar system. They are capable to perform real-time, high-resolution measurements. The set-up of these instruments, the novel technical solutions, and the signal processing technique introduced are discussed. The results obtained with such instruments during measurement campaigns are presented as well. [C314]

## "2004 Second International Workshop Ultrawideband and Ultrashort Impulse Signals (IEEE Cat. No.04EX925)"

{no data available} [C315]

## "Ultrawideband systems-features and ways of development"

Consideration is given to the main specific features of ultrawideband (UWB) systems and possibilities of these systems to increase essentially the information performance of radars and communication. The problem of particular interest is the difference in constructions between UWB and conventional radar systems operating in a narrow frequency band. The difficulties caused by these differences when constructing UWB systems are determined. Also discussed are the ways to counter these difficulties, which makes it possible to expand the UWB radar application area and realize the advantage over conventional radar systems. [C316]

## "A few examples of interferometry applications in space-related active and passive remote sensing"

The paper describes only a few examples of interferometry applications for space related active and passive remote sensing scenarios. Pulses with defined bandwidths as needed in a total system picture are applied (active remote sensing). Several accurate radar remote-sensing satellites have been produced under ESA's technical management. Work continues (www.esa.inQ) and new missions are developed. Also, such activities are ongoing at the level of National Space Agencies (Italy, Germany, etc.). Stability in instrumentation and related signal settings permits to make further advances and interferometry applications are advancing strongly. Some examples are shown, from which one observes, that accuracy is a very important factor. Ultra stabile reference clock signals are needed in interferometry applications with as an extreme example an experiment to perform Very Long Baseline Interferometry (VLBI) tracking of a weak transmission signal at Saturn's distance. Clock stability, using masers with 10"14 to 10"15 sec accuracy is needed here. [C317]

## "Wideband radar remote sensing of the atmosphere: a data interpretation problem"

Wideband radar application for the remote sensing of the atmosphere is considered. Features of distributed targets as objects of wideband radar observations are shown. The difficulties of the retrieval meteorological information from the returns are discussed. Prospect of UWB radar for remote sensing is reviewed. [C318]

## "The VIY-2 ground penetrating radar"

The VIY-2 ground penetrating radar (GPR) with unique sounding possibilities and use simplicity is presented at this paper. The VIY-2 GPR combines all units (synchronizer, transmitting and receiving modules, power supply and antenna system) into single case. The VIY-2 GPR communicates with computer via standard interface RS232 or USB 1.0. Utilized by the VIY-2 GPR technical solutions reduce deployment time and simplify survey process. The VIY-2 GPR design features and its components interaction are considered. Some field results are also presented. The VIY-2 GPR design concept allows reducing the data acquisition time, optimizing the time-varying gain control function, applying depth-stacking dependence, controlling the survey window position and interference reducing by pulse repetition frequency randomizing. [C319]

## "UWBWA SAR imaging modeling and its time-frequency processing"

In the ultra wideband, wide-angle synthetic aperture radar (UWBWA SAR) imaging, scatterers often perform the aspect angle and frequency dependent reflectivity character, which usually is neglected in traditional imaging processing. A UWBWA SAR imaging model is studied in this paper first. Based on the model, a new imaging format with time-frequency processing is proposed. The new imaging format can extract the aspect angle and frequency dependent information of scatterers, which is valuable in targets recognition. Simulations show the precision of information extraction using the new imaging format. [C320]

## "Impulse wave estimation based on analytic wavelet in UWB-radar"

A method is discussed in this paper for analysis of received ultra wideband pulse in noise based on analytical wavelet transform. Using analytical version of wavelet, the feather of the impulse shape and position can be

identified from the transform results. The impulse samples can be reconstructed and have a noise reduction by employing a thresholding technology to deal with the coefficients. The echo time delay of dispersed target components can be estimated in favor of further processing of range profile of UWB-radar. [C321]

## "Increase of efficiency of suppression of reflecting from handicaps (interferences) such as "angel-echo" at the expense of use of multifrequency signals"

Problems of increase of efficiency of selection of handicaps (interferences) such as the "angel-echo", overloading a receiving (an acceptance) channel of the radar station of seaside referencing surveyed, performances of these handicaps (interferences) are parsed and the method of their selection suppression is offered at the expense of use of multifrequency signals. [C322]

## "Spatial and power characteristics of the ultrawideband reflector"

The electrodynamic method of calculation the spatial-temporary characteristics of large electrical sizes mirror antennas with the help of integrated representations for the surface current density is offered with account of conditions on the edge in the Meixner's form. The settlement power characteristics used for determining potentialities of radar-tracking processing of an accepted signal are given in the work. [C323]

## "PulsON P200 UWB radio: simulation and performance results"

In 1999, Time Domain (TDC) introduced the first ultra-wideband (UWB) radios using the PulsON P100 chipset. In 2002, a second-generation chipset, the PulsON P200, was introduced. It consists of a P200 timer (T2), P200 correlator (C2) and P200 digital baseband (DBB) chip. The chipset has been incorporated into the P200 UWB radio platform. The P200 radio is architected as an 8-correlator transceiver. The correlators are configured to minimize acquisition time, provide rake receiver gain, enable higher order modulation, provide ing of in-band jammers and provide a means to record the entire received waveform (waveform capture). The radio relies on coherent signal processing. Energy from up to 1024 pulses can be coherently summed thereby providing 30dB of process gain. Additional process gain is realized from duty cycle as the 0.5 ns waveform is transmitted once every 104ns. As part of the design process, the radio was well simulated and a link budget was produced. Upon completion, the radio performance was compared to the predicted values. The radio has been tested as a communications system, a ranging system and as a mono-, bi- and multi-static radar. This paper summarizes the radio architecture, modulation, link budget, simulation, and performance results. [C324]

## "33rd European Microwave Conference Proceedings (IEEE Cat. No.03EX723C)"

First Page of the Article [C325]

## "2003 IEEE Conference on Ultra Wideband Systems and Technologies (IEEE Cat. No.03EX759)"

First Page of the Article [C326]

## "UWB multiple access performance using time hopped pulse position modulation with biorthogonal signaling"

This paper extends previous UMB multiple access (MA) performance characterization by combining pseudorandomly coded, time hopped pulse position modulation (TH-PPM) with 4-ary biorthogonal communication signaling. Communication performance for the hybrid TH-BPPM technique is first validated for a single user operating over an AWGN channel. Single user results are then extended and MA performance characterized for both synchronous and asynchronous networks containing up to 15 users. In both cases, the proposed 4-ary TH-BPPM technique with Gold coding achieves nearly identical performance as previously demonstrated MA methods employing binary TH-PPM. A key benefit afforded by the 4-ary TH-BPPM technique, given fixed average power and symbol length constraints, is a doubling of the effective data rate while achieving identical bit error rate performance. [C327]

## "Novel planar ultra wideband stepped-fat dipole antenna"

This paper presents an ultra wideband (UWB) planar stepped-fat dipole antenna. Comparing to conventional fat-dipole antennas, the novel antenna has stepped arms for impedance matching. The stepped arms make wideband impedance matching. A prototype antenna is designed for an ultra wideband ground penetrating radar (UWB-GPR). From EM simulations, dimensions of antennas are chosen for the better performance. For verification, the antenna is fabricated and measured. It is shown that return loss of the antenna between 0.5 GHz and 2.7 GHz is better than 10 dB. [C328]

## "Microwave-based detection of breast cancer using the generalized likelihood ratio test"

In this paper the generalized likelihood ratio test (GLRT) is applied to the problem of detecting breast cancer via ultrawideband microwave radar. We propose a model for the covariance matrix of the clutter due to breast tissue heterogeneity and show that the GLRT with clutter whitening easily detects and localizes tumors under diverse circumstances. We illustrate the performance of the GLRT and clutter whitening transformation with simulated data from a 2-D realistic numerical breast model. A statistical analysis of the GLRT under matched and mismatched conditions characterizes the power of the test and we provide examples of detectors with mismatch in tumor size and tumor location. [C329]

## "Combining GPR and EMI data for discrimination of multiple subsurface metallic objects"

Cleanup of subsurface metallic objects such as unexploded ordnance (UXO) constitutes an urgent problem worldwide. The heart of the problem is discrimination, as opposed to detection. Ultra-wideband electromagnetic induction sensors (UWB EMI), operating from a few Hz up to 100s of kHz, have shown considerable promise in subsurface discrimination of metallic objects. Unfortunately, a great many objects, including widespread clutter items, produce very broad, smooth EMI signal patterns, over a number of decades of frequency. Shape identification is complicated by the sensitivity of EMI fields to metal type. UWB ground penetrating radar (GPR) has also shown definite discrimination capability for characterizing subsurface metallic targets. Uninfluenced by metal type, GPR is capable of registering complex natural resonances from which target length can be estimated. Further, examination of the spatial patterns of GPR signals can indicate the (X,Y,Z) locations of targets, even of multiple targets present simultaneously in the incident beam. In this paper we consider potential collaborative roles of UWB GPR and UWB EMI for discrimination of multiple subsurface metallic objects. Rigorous 3-D FDTD models demonstrate GPR's ability to estimate target positions, orientations, and length even when reflections overlap. These data can then be used to constrain inversion of UWB EMI patterns. Processing of EMI measurements based on prior estimates of object location and orientation successfully extracts distinct frequency response signatures for two very closely spaced objects. [C330]

## "Spectrum management issues relevant to the introduction of ultra-wideband technology"

This paper presents some of the challenges that face the introduction of ultra-wideband (UWB) technology in wireless applications intended for commercial use, summarizes relevant regulatory and standards developments, and addresses potential implications on spectrum management and radio regulations. [C331]

## "Ultra-wideband object characterization via A-scan"

In this paper a novel method for ultra-wideband object characterization using a single A-scan is presented. The impulse response of the arrangement at a single measurement position is called an A-scan. The data of an A-scan is processed with the novel wavelet based pulse reconstruction to determine five parameters of the pulse approximation. The width of different copper plates can be characterized by the dilatation of the reconstructed pulse which is one of the five parameters. To get real radar reflection data an ultra-wideband impulse radar setup was used. The presented results testify, that there is a direct link between the parameter dilatation factor and the width of a centered copper plate. To verify the results of the measurement analysis a simulation tool was developed. The presented results of the simulation accord very good with the measurement. [C332]

## "Note on antenna design in UWB wireless communication systems"

Requirements for the antennas in wireless communication systems are presented, from a systems point of view. Differences between narrowband and ultrawideband systems in assessing system performance are discussed. Several parameters are introduced for the antennas in ultra-wideband wireless communication systems, to evaluate the performance of antennas based on the system requirements. As an example, a transmitting/receiving antenna system comprising two identical planar bow-tie antennas is analyzed numerically and experimentally in both time and frequency domains. By the introduced parameters, the effects of source and template pulses on the performance of the antenna system are also investigated. [C333]

## "Cost-minimized 24 GHz pulse oscillator for short-range automotive radar applications"

This paper reports on the design of ultra-wideband 24 GHz pulse oscillators developed for automotive radar applications. Due to system considerations (range resolution, dynamic range), such oscillator modules need to generate ultra-short coherent pulses. Measurement results of prototype oscillators demonstrate +5 dBm peak output power, less than 1 ns pulse width and excellent coherency. The oscillators were applied in a radar sensor and good performance was achieved. [C334]

## "Optimization of the dielectric embedded dipole antenna"

Based on the developed theoretical model of the DEDA analysis of its performance and optimization of its structure has been performed. According to simulations the optimized version of the antenna has 50% larger bandwidth, radiates pulse with 1.6 times larger amplitude and has small late-time ringing than the first DEDA antenna. [C335]

## "Operation of "Big Ear" for radar scattering measurements"

The Big Ear was such a robust design that it was able to produce calibrated ultrawideband scattering signature data and ISAR images when used as an offset feed compact range. It also served as a platform for important measurements of FOPEN scattering signatures and FOPEN foliage propagation performance. For over 10 years, this system produced data of significance for the radar sensing community at UHF and VHF frequencies. [C336]

## "A moving target detection filter for an ultra-wideband radar"

A time modulated ultra-wideband (TM-UWB) through-wall impulse radar currently has been developed at Time Domain Corporation, Huntsville, AL, which detects the motion of people in range and azimuth through non-metallic walls. The radar operates in real-time with 3Hz update rate. In order to detect the motion of people moving with different velocities, a digital moving target detection (MTD) filter has been developed which is implemented in the software of the radar. The MTD filter is an IIR high-pass filter and it helps reject the stationary (time history invariant) clutter. Results on the time vs. slow-frequency (Fourier transform of slow-time response) distribution for targets moving at different velocities are presented for a given update rate. The transfer function of the MTD filter as a function of a target velocity is also presented for a given update rate. [C337]

## "Proceedings of the 2003 IEEE Radar Conference (Cat. No. 03CH37474)"

First Page of the Article [C338]

## "Sidelobe response of antennas to short pulse signals"

We consider the waveforms of signals received in the sidelobe region of antenna, when the signals are of very short duration. It is shown that the output signal waveforms can be very different from those of the input signal. An analytical theory is presented to explain these effects, and several examples are presented to illustrate the effects and to show the validity of the analysis. A number of applications are suggested. [C339]

## "Radiation efficiency of the large current radiators. Electrodynamic simulation"

The paper presents the results of electrodynamic simulation, using the FDTD method, of the radiation of ultrawideband (UWB) pulse electromagnetic fields by radiators built as Harmuth's large current radiators. The dependencies of the time characteristics of the radiated pulses on a dimension of the radiator are presented. [C340]

## "The UWB receiving loop antenna"

A simple method is presented for determining the parameters of a loop antenna intended to receive ultrawideband (UWB) pulse signals. The influence of the loop dimensions and load resistance on the broadbandness and sensitivity of the UWB receiving loop antenna are analyzed. [C341]

## "Solution of the inverse problems of subsurface radiolocation"

A common approach is stated to the solution of an inverse scattering problem from the results of an exploration of a subsurface radio-stage by ultrawideband short-pulse signals. At the first stage, with the help of multiple loggers, the time-space matrix of a scattered electromagnetic field is shaped. The second stage is bound to the definition of the physical properties of the subsurface area. At the third stage, the detection procedure is carried out by shaping a 2D or 3D image of the subsurface area. Examples of 2D images restored by a spectral method are reduced. At the fourth stage, the procedure for reconstructing the geometrical and physical properties of subsurface objects is carried out. The procedure is based on a method of computing diagnostics (MCD). [C342]

## "Single and multi-carrier UWB communications"

In this paper we study single and multi-carrier ultra-wideband (UWB) communications focusing on spectral efficiency and system performance. We begin by examining the spectrum of the general form of single carrier

ultra-wideband systems and argue that multi-carrier UWB systems provide better utilization of the available spectrum. We then describe a general form for multi-carrier UWB systems and study their performance focusing on the multipath interference (MI) and interchannel interference (ICI). The results of this analysis lead us to a signal design approach for a multi-earner UWB system named UWB-OFDM. [C343]

## "The evolution of UWB technology"

This talk will review the development of time domain electromagnetics by this writer and others over more than a 40-year period and show how the work contributed to the growth of ultra-wideband (UWB) radar and communications. It will also review some of the latest advancements made in the field of communications by investigators making presentations at this UWB session at RAWCON and attempt to put their work in perspective. Additionally, some remaining problem areas will be identified. [C344]

## "Cost-Minimized 24 GHz Pulse Oscillator for Short-Range Automotive Radar Applications"

This paper reports on the design of ultrawideband 24 GHz pulse oscillators developed for automotive radar applications. Due to system considerations (range resolution, dynamic range), such oscillator modules need to generate ultra-short coherent pulses. Measurement results of prototype oscillators demonstrate +5 dBm peak output power, less than 1 ns pulse width and excellent coherency. The oscillators were applied in a radar sensor and good performance was achieved. [C345]

## "Investigation of ultrawideband pulses in wideband helix traveling wave tubes"

Summary form only given, as follows. The study of pulse propagation and distortion in traveling wave tubes (TWTs) has many applications. First, it is an attractive "diagnostic method" to characterize important properties such as dispersion and nonlinear distortion over a broad frequency band. Second, it is relevant to assessing the utility of TWTs as amplifiers for impulse radio, impulse radar, or other ultrawideband signal applications. We present results of a new model for analysis and numerical simulation of transient TWT excitation. The analysis applies a 1D linear model to examine pulse propagation in a TWT, including dispersion, space charge effects, and attenuation. Nonlinear effects are investigated using a 1D numerical particle-in-cell simulation. Fields are calculated using the pseudo-spectral time-domain (PSTD) method with a modification to incorporate helix waveguide dispersion effects into a 1D model. Progress with experimental investigations on the XWING tube will be discussed. The XWING (eXperimental WIsconsin Northrop Grumman) tube is a Northrop Grumman custom modified wideband (2-6 GHz) traveling wave tube, with multiple access ports that allow diagnostic access to the wave as it propagates along the tube. [C346]

## "Conference Record of the Thirty-Sixth Conference on Signals, Systems and Computers (Cat. No.02CH37387)"

First Page of the Article [C347]

## "Specular multipath analysis for a coherent ultrawideband random noise radar"

First Page of the Article [C348]

## "Radar investigations of breaking water waves at low grazing angles with simultaneous high-speed optical imagery"

Radar scattering experiments were carried out at the wavetank facility at the University of Maryland-College Park. Spilling and plunging breakers were generated by means of a chirped wave packet, and were then imaged with a high-speed camera. Simultaneously, the radar backscatter generated by the breakers at a nominal grazing angle of 12 degrees was measured by an ultrawideband, dual-polarized, X-band radar with a range resolution of approximately 4 cm. This experimental setup also included a moving instrument carriage that allowed the sensors to follow the breakers throughout their entire evolution. In conjunction with numerical simulations, these experiments can guide the development of realistic scattering models by identifying the important wave features and the corresponding scattering mechanisms. [C349]

## "Investigation of ultrawideband pulses in wideband helix traveling wave tubes: Theory and simulation"

Summary form only given. The study of pulse propagation and distortion in traveling wave tubes (TWTs) has many applications. First, it is an attractive "diagnostic method" to characterize important properties such as dispersion and nonlinear distortion over a broad frequency band.. Second, it is relevant to assessing the utility of

TWTs as amplifiers for impulse radio, impulse radar, or other ultrawideband signal applications. We present initial results of new models for analysis and numerical simulation of transient TWT excitation. The analysis applies a 1D linear model to examine pulse propagation in a TWT, including beam loading, frequency-dependent gain, circuit dispersion and space charge effects. Nonlinear effects are investigated using a 1D dispersive time domain numerical particle-in-cell simulation. A novel method of incorporating the helix waveguide dispersion into a 1D telegrapher-like equation will be presented. Progress and plans for experimental investigations on the XWING tube will be discussed. The XWING (eXperimental WIsconsin Northrop Grumman) tube is a Northrop-Grumman custom modified wideband (2-6 GHz) traveling wave tube, which allows access to the wave as it propagates along the tube as well as access to the spent beam [C350]

## "Modelling of ultrawideband echoes from rough dielectric surfaces by calculating physical optics currents"

This paper presents anew method for the deterministic prediction of UWB radar clutter. It is based on a physical optics approach combined with a discrete Fourier transform. Results for different kinds of realistic measurement situations are presented [C351]

## "Ultra-wideband for navigation and communications"

Precision coordinated maneuvering of multiple space vehicles would offer significant performance advantages to both commercial and scientific missions by increasing the versatility and potential capabilities of the formation. Ultra-wideband systems can provide centimeter level accuracy ranging measurements over distances of kilometers, using only milliwatts of power from an omni-directional transceiver no bigger than a pager. Using these precise range measurements between the vehicles, it is possible to resolve the relative geometry of the entire formation. The ultra-wideband (UWB) system presented in this work is not RADAR; it is active ranging over a code divisible multiple access (CDMA) communications channel with no carrier frequency. Each transceiver is given a unique pseudo-random noise code, which is broadcast using pulse position modulation (shifting pulses or monocycles forward or backward in time relative to an constant rate pulse train), in a type of call and return scheme to measure time of flight between vehicles. As a byproduct of CDMA encoding, a UWB navigation system could also provide a megabit per second communications channel to each vehicle, providing further savings of power, weight, and cost. A simple ranging experiment has been designed as a proof of concept. The experiment includes bench top equipment for sending and receiving ultrawideband monocycles and post processing algorithms for determining range. To implement the system, it was necessary to design and develop ultra-wideband antennas to efficiently propagate the monocycle pulses with minimal distortion. These antennas were tested in an anechoic chamber constructed for the ranging experiment and data on their characterization is presented in this paper. This paper presents the experimentally derived ranging accuracies and compares them to theoretically derived ranging accuracies for the UWB based measurement. It also provides a characterization of the distortions encountered in the pulse waveform during transmission and reception from our custom antennas. UWB ranging systems offer a robust solution to relative vehicle navigation in a variety of space mission configurations [C352]

## "Dual frequency measurements of ocean forward scatter with an ultrawideband radar"

This paper presents an experiment description, along with data examples, for ultrawideband radar measurements of low grazing angle forward scatter associated with a test target mounted above a wind-disturbed sea surface. The measurement radar used sub-nanosecond transmit pulses (0.15 ns and 0.25 ns 3 dB pulse widths) at center frequencies of 9 and 4 GHz to achieve resolutions finer than 3 cm in the range dimension. This resolution was sufficient to fully resolve direct and multipath (both single and double bounce) contributions to the signal reflecting from a tower-mounted retro reflector. The geometry produced a nominal 3 degree grazing angle for forward scatter. Dual frequency measurements for a wind-disturbed ocean surface highlight changes in the magnitude and the location of the scatter components with time [C353]

## "Reopening the electromagnetic spectrum with ultrawideband radio for aerospace"

Analog radio has been in use for 100 years, but the authors take a different approach to the radio spectrum. Discrete, low-power pulses spread over many gigahertz allow us to manage the spectrum by time, instead of frequency. Time modulated ultrawideband (TM-UWB) radio technology, implemented in Time Domain's PulsONTMchip, offers far-reaching impact for new tool sets for the aerospace industry. PulsONTMtechnology is based upon the precise correlation of discrete pulses transmitted across a 2 gigahertz or larger spectrum and processed in the time domain. This ultra-low power digital data stream can be used for voice, data, and video communications and new applications in geopositioning and precision radar surveillance. TM-UWB features ultra-low power, immunity to multipath (Rayleigh fading), spectrum sharing, virtual undetectability, and capacity for

very high bandwidth and channelization [C354]

## "Discussion of the K-pulse conception"

A number of ultrawideband radar target discrimination measures using K-pulse conception for the simplest object characterized by a single complex natural frequency has been investigated by a computer simulation. Besides the traditional weight function, the Hemming's function and function with the Fourier transform coinciding with the Butterworth function have been used. The Hemming's function has some advantages [C355]

## "Blind polarimetric equalization of UWB SAR imagery"

Polarimetric synthetic aperture radar (SAR) imagery is susceptible to degradation due to non-ideal responses in antennas and other hardware. While a number of polarimetric calibration procedures have been developed to compensate for these effects, most are limited to narrowband SAR systems. The few that are applicable to ultrawideband (UWB) SAR suffer from a dependence on high-quality antenna measurements or detailed electromagnetic scattering models of test targets. Here a blind polarimetric equalization (BPE) technique is developed that uses second-order statistics from clutter or targets of opportunity to estimate the SAR system response. These estimates are then used to remove crosstalk contamination and imbalances between polarimetric images. The novel frequency domain implementation makes BPE suitable for ultrawideband SAR systems. BPE is an image post-processing procedure that does not require changes to radar hardware, antenna measurements, or target predictions [C356]

## "Microwave breast tumor detection: antenna design and characterization"

Microwave detection of cancerous tumors has been of great interest as an alternative or a complementary method to ionizing radiation methods such as computed tomography or mammography. Microwave imaging of the human body or its parts has been investigated over a considerable period of time. Limited detection capabilities and computational complexities hamper practical implementation and the promise of clinical use of these techniques. Among various non-superficial tumors, breast cancer tissue has significantly different electrical properties at microwave frequencies from those of healthy tissue. This feature resulted in a very promising approach to cancer detection. Furthermore, this new approach avoids many complexities of microwave imaging. It involves the identification of regions of increased scatter as opposed to directly imaging tissue electrical properties. The identification is based on techniques previously used in ground penetrating radar with suitable modifications. In our research, we have further explored this means of breast tumor detection, but with a considerably different system configuration and signal processing. Our approach appears more amenable to practical implementation, and the preliminary evaluation yielded encouraging results (Fear and Stuchly 1999). In this contribution several antenna designs are evaluated for effective radiation of the ultrawideband pulse which is used for tumor detection [C357]

## "Modelling of air-soil interface clutter for ultrawideband radar"

This paper presents our global approach to model ultra-wideband (UWB) clutter. In this approach, we consider plane wave scattering (in the time domain) from a rough air-soil interface. The time-domain scattering is computed via two different techniques. The first one is a two-dimensional (2D) finite difference time domain (FDTD) algorithm, which is particularly well adapted to frequency-dependent subsoils. The second method is processed in the frequency domain prior to a discrete Fourier transform (DFT) which is performed to come back to the time domain. With this last method, we can integrate system parameters and statistically rough surfaces into our model [C358]

## "Projection pursuit classification methods applied to multiband polarimetric SAR imagery"

Results are presented for an experiment utilizing land calibration targets imaged by the NRL ultrawideband synthetic aperture radar (NUWSAR). Projection pursuit statistical analysis tools were applied to a set of simultaneous L- and X-band polarimetric images of dihedrals and trihedrals to determine optimal and minimal combinations of polarization and radar bands for identifying different scatterers. The normalized mutual information function (NMIF) was used as a quantitative optimization measure. It was calculated for a series of combinations of frequencies and polarizations, beginning with the maximum set of all six elements (HH, VV, and HV for each of X- and L-bands), then continuing with successive elimination of single elements, then pairs, and so on. In principle, this will produce 6! (or 720) of such combinations. To illustrate the principle, only a subset of element combinations were eliminated, and it became clear that the NMIF decreases rapidly as one goes beyond 2 members. Results presented suggest that a `spectral' display of these NMIF results correlates with scale size and shape of targets, and that different types of targets in the scene display a robust NMIF spectral signature. This leads one to hypothesize that such an approach may lead to NMIF library signatures for

classification of natural and man made targets similar to the way optical hyperspectral library signatures are utilized, but using microwave radar band and polarization combinations instead [C359]

## "Ambiguity function of an ultrawideband random noise radar"

The University of Nebraska has developed an ultrawideband (UWB) random noise radar system which transmits an ultrawideband random noise (Gaussian) waveform with uniform power spectral density (PSD) in the 1-2 GHz frequency range. We look at the range and range rate resolution issues by analysing the Woodward's (1955) ambiguity function. In general, the radar signal ambiguity function is defined as the normalized response of a filter matched to a return signal with range rate V0, to a return signal with range rate Vl. It describes the resolution properties of a given signal in range and range rate. However, for a random noise radar a correlator matched to the transmit process is required. Therefore, an analogous ambiguity function may be defined as the expected value of the response of the correlator matched to a target moving with range rate V01, to the return signal from the target with range rate V1. Moreover, for a UWB transmit random process, the compression or stretch due to the range rate on the envelope of the return process cannot be ignored [C360]

## "SAR imaging using fully random bandlimited signals"

A coherent ultrawideband (UWB) random noise synthetic aperture radar (SAR) has been developed and tested at the University of Nebraska. It has been experimentally shown that this type of radar is capable of extracting the phase and the amplitude of the backscattered signal, thus enabling us to create target profiles in the frequency domain. The use of fully random waveforms (bandlimited noise) as the transmit signal is analyzed. A UWB signal model is developed and radar signal processing is simulated to yield the statistical characteristics of image formation using stochastic waveforms. The influence of the UWB signal characteristics on the image quality is estimated and represented graphically [C361]

## "Ultrawideband noise synthetic aperture radar: theory and experiment"

The authors demonstrate the ability of the ultra-wideband random noise radar to be used as a SAR imagery instrument. Experimentation with processing data collected over different angles clearly shows that theoretical cross-range and slant-range resolution are achieved. It was also observed that, due to the waveform structure end `boom-SAR' geometry, cross-range walk can be a problem, especially in short-range measurements. Special post-processing methods (such as coherent summing sub-arrays of partitioned and separately processed narrower angle data sets) are under investigation to reduce distortions [C362]

## "Radar cross section dependence on wind speed"

YSCAT was an ultrawideband (2-20 GHz), near constant beamwidth scatterometer intended to provide radar cross section measurements at varying radar and environmental parameters. YSCAT was deployed on the CCIW (Canada Center for Inland Waters) tower on Lake Ontario for a period of six months in 1994. Using YSCAT data, this paper reports (1) observance of a “low wind-speed cutoff”, the fall-off of σ0which occurs at low wind speeds, and (2) the results of a fitting 2-component lognormal/Rayleigh combined probability distribution to the observed backscattered power measurements at C-band (5 GHz) and X-band (10 GHz). The observed characteristic trends of the fitted pdf model parameters verses wind speed are shown and discussed [C363]

## "Measurements of ocean forward scatter with an ultrawideband radar"

This paper presents an experiment description, along with data examples, for ultrawideband radar measurements of low grazing angle forward scatter associated with a test target mounted above a wind disturbed sea surface. The measurement radar used subnanosecond transmit pulses (0.15 ns, 3 dB pulsewidth) at a 9 GHz center frequency to achieve resolutions as fine as 2 cm in the range dimension. This resolution was sufficient to fully resolve direct and multipath (both single and double bounce) contributions to the signal reflecting from a tower mounted retro reflector. The geometry presented a nominal 3 degree grazing angle for forward scatter. Dual polarized data examples, taken for a variety of wind conditions, highlight changes in the magnitude and the location of the scatter components with time [C364]

## "ISAR turntable experiments using a coherent ultrawideband random noise radar"

We have demonstrated that the ultrawideband random noise radar may be used in the ISAR mode. We pursue turntable experiments on various target arrangements containing canonical shapes and structures with emphasis on polarimetry. By using joint time-frequency transforms, we are able to achieve good cross-range resolution. Good slant range resolution is achieved by the ultrawide bandwidth of the transmit signal. Work is also ongoing on combining two orthogonal copolarized images (VV and HH) and a single cross-polarized image (VH or HV)

into a RGB color composite image [C365]

## "An ultrawideband microwave source based on a Zeeman tuned atomic iodine laser"

Summary form only given. There has been a great deal of interest in using optical techniques to generate microwave signals. A compact, laser driven microwave source has interesting potentials for various radar applications. Our concept is based on locking two hyperfine lasing transitions of atomic iodine to produce radiation modulated at their difference frequency (13.6 GHz). Such a passive technique does not require the application of an intracavity GHz modulator or the stabilization of the laser frequency. Our concept, demonstrated with a low-power photolytic iodine laser, can be upscaled to a high-power chemical oxygen iodine laser [C366]

## "Ultra-wideband source research"

Ultra-wideband (UWB) microwave sources and antennas are of interest for a variety of applications such as transient radar, mine detection and unexploded ordnance (UXO) location and identification. Much of the current research is being performed at the Air Force Research Laboratory (AFRL) at Kirtland AFB, NM, USA. The approach to high power source development has included high pressure gas switching, oil switching and solid-state switched arrays. Recent advances in triggered gas switch technology and solid-state-switched shockline technology have opened up new possibilities for the development of much higher power systems and have thus opened the door to many new applications. The research into UWB transient antennas has also made significant contributions to the development and improvement of wideband continuous wave (CW) antenna designs and has brought new knowledge about the complex behavior of ferrites, dielectrics and resistive materials in short pulse, very high voltage environments. This has in turn led to advances in the technology of transformers, transmission lines, insulators and UWB optics. This paper reviews the progress to date along these lines and discusses new areas of research into UWB technology development [C367]

## "Fiber-optic control of a time-steered millimeter-wave transmit array"

An ultrawideband, fiber-optic, true time-delay, millimeter-wave array transmitter is demonstrated. The beamformer is based on dispersive-prism, optical-delay lines and exhibits squint-free ±60° steering in azimuth across the entire Ka (26.5 to 40 GHz) microwave band. This is believed to be the first fully functioning demonstration of a photonically controlled wideband, millimeter-wave transmitter system [C368]

## "Three-dimensional FDTD analysis of an ultrawideband antenna-array element for confocal microwave imaging of nonpalpable breast tumors"

We are developing a confocal microwave imaging system for the detection of early-stage breast cancer. Our proposed microwave sensor represents a novel adaptation and application of the principles of ultrawideband radar technology and confocal optical microscopy. The sensor is comprised of an electronically switched monostatic antenna array that, synthetically focuses a low-power pulsed microwave signal at a focal point within the breast and collects the backscattered signal. Malignant tumors have a significant scattering radar cross section due to the large dielectric contrast between malignant tumors and adjacent normal breast tissue. Therefore, the intensity of the backscattered signal increases dramatically when the focused transmitted signal encounters a malignant tumor. Two key performance specifications for the microwave sensor are the signal-to-clutter (S/C) ratio, defined as the ratio of the peak backscatter return from a tumor to the peak backscatter return from clutter, and the system dynamic range, defined as the ratio of the peak pulse power of the source to the system noise floor due to reverberations and thermal noise. Our two-dimensional FDTD simulations involving the computation of S/C ratios have demonstrated the feasibility of detecting lesions as small as 1 mm in diameter. In this paper, we highlight the results of our three-dimensional simulations of an antenna-array element placed at the surface of a breast tissue half-space [C369]

## "Doppler measurements using a coherent ultrawideband random noise radar"

The University of Nebraska has developed a random noise radar system which transmits an ultrawideband random noise waveform with a uniform power spectral density (PSD) in the 1-2 GHz frequency range. Simulation studies and controlled laboratory tests confirm the system's ability to preserve the instantaneous phase of the received signal (Narayanan et al. 1996, 1997). The potential of the system to characterize the Doppler shift of moving targets exhibiting varying linear and rotational velocities was clearly demonstrated (Narayanan et al. 1997). This paper provides with the results of field experiments at a range of about 200 m which confirm the ability of the system to be used as a Doppler radar in operational scenarios [C370]

## "High-speed opto-electronic transient waveform digitiser"

In many military systems there is an increasing pressure to gather more and more data on the environment surrounding a platform or weapon. Analogue to digital converters are required because the data gathered from most sensors is analogue and the form required for computers and digital signal processing is digital. Current ultrawideband radar and electronic warfare applications may require data to be digitised at 10 GSa/s with 8-bit resolution or more. This is far in excess of the performance of current commercial monolithic electronic ADCs. In fact, the ADC is often a limiting factor in the overall system performance. This paper describes a transient waveform digitiser that uses an optical technique to convert a single (electrical) signal into a series of time delayed copies. Traditional repetitive sampling techniques can then be used to achieve a high overall sampling rate. Results are presented for a prototype digitiser operating at 16 GSa/s with 8-bit resolution [C371]

## "The problems of small base ultrawideband radar"

Simulation results have shown a perspective of application of approach for the radar object (RO) form evaluation with use of genetic functions when aperture synthesis realizes a small angle base of surveillance. The accuracy of the object form evaluations increases with the decrease of sounding pulse duration and increase of the distance between the receivers. Application of a suggested scheme of coordinate determination for this aim allowed us to obtain the object form evaluations when the receiving system base is 10 m. Influence of measuring noise on the accuracy of approximation and determining of coordinates makes it necessary to increase the signal/noise ratio, e.g. owing to the increase of the radiated signal power. Besides, the accuracy of the RO form evaluation will increase and processing velocity will decrease when adding new genetic functions. A search of optimum composition of genetic functions is a significant task [C372]

## "Dual polarized, UWB radar measurements of the sea at 9 GHz"

An ultrawideband, dual polarized, dual waveform, instrumentation radar has been described and experimental measurements of fixed test objects and of a disturbed sea surface have been presented. The two cm range resolution of the system separates the contributions of individual scattering features on the ocean surface and is providing an increased understanding of the composition and behavior of radar sea clutter at low grazing angles. The experimental results have emphasized fundamental differences in the character of the clutter as a function of both polarization and radar resolution [C373]

## "Electromagnetic Pulsed-Beam Wavelets for Radar"

The physical wavelets introduced earlier are studied in greater detail. They are causal pulsed-beam solutions of the Wave equation or Maxwell's equations parameterized by their point and time of emission, the radius of the emitting aperture, the direction of propagation and the pulse duration. They are related to the "complex-source pulsed beams" studied by Heyman and Felsen, but have an additional parameter Г‚Вї which controls their oscillation and bandwidth. We derive the far fields and time-domain radiation patterns and confirm that by choosing large values of Г‚Вї, the beams can be made arbitrarily narrow and well-collimated. Applications to ultrawideband radar are indicated. [C374]

## "Modification of the aperture synthesizing method for underground sounding data processing"

The creation of subsurface radar systems is a significant problem in modern radio physics and thus has been investigated by many authors. The ultrawideband (videopulse) scanning systems usually produce data which are hard to interpret. This leads to the necessity of developing efficient data processing algorithms. The synthetic aperture method (SAM) seems to be one of the most powerful techniques of data processing in this area. SAM is based upon the following two-stage procedure: 1) application of a compression filter to the signals reflected by the medium (echo-returns), the filter indicates the presence of the object reflected signal; and 2) spatial convolution of the obtained set of the echo-returns. Natural and numerical experiment results show that useful algorithms for subsurface data processing can be developed on the basis of the synthetic aperture algorithm. Nevertheless some modifications of this algorithm have to be carried out in order to achieve accessible results in real media data processing. In this paper the algorithms aimed at the correction of the inverse-matched filter and computation time reduction are presented [C375]

## "The detection of AP mines using UWB GPR"

In the frame of the Belgian interuniversity project HUDEM (HUmanitarian DEMining), the Royal Military Academy (RMA) has started a research on the detection of plastic AP mines by means of ultrawideband ground penetrating radar (UWB GPR) i.e. GPR using ultra-short electromagnetic pulses (<200ps). Because AP mines are not buried at great depth and are very small objects, conventional GPR is not very well suited to detect all the mines without failure and to discriminate between a mine and a mine-like target. In the first part of the present paper we give a brief overview of the HUDEM project, its technical organization and test facilities. We

also present results of outdoor trials with different GPR systems. We will highlight the advantage of UWB radar systems. Finally we motivate and discuss the development of some very small (10Ч5 cm), ultra-wideband directive TEM horn antennas. These antennas can be used in UWB applications, and they are, thanks to the reduced dimensions, suited for hand-held applications [C376]

## "Surface penetrating radar image quality"

The detection of buried or surface laid mines by ultrawideband, ground-probing radar systems is currently receiving much attention. The radar signature of the mine may be known, in which case a range of techniques can be used to characterise the received signal. These range from, in the case of surface laid mines, characterisation of the sequence of reflections caused by external reflections, creeping waves and internal reflections such as the Glory wave; singularity expansion methods (SEM); resonance characterisation via such techniques as Prony; through to wavelet analysis. For buried mines the range of classification options is more limited as the host material significantly modifies the impulse response of the target, but shallow mines may still be identifiable. The extent of validation trials on most of these processing methods is limited. This paper considers some of the parameters, whereby the discrimination of the spatial signature of the mine is based solely on a statistical assessment of the radar image data and a characterisation of the radar sensor [C377]

## "The development of an advanced mine detection system at the Norwegian University of Science and Technology"

Ground-penetrating radars have been in use for years. A fundamental problem has, however, been an unacceptably high false alarm rate in many circumstances. The Norwegian University of Science and Technology (NTNU) is therefore currently developing an advanced ultrawideband ground penetrating radar system (RadioStar) that is expected to improve the performance, in particular in the field of mine detection [C378]

## "Frequency dependence of ATD performance in foliage-penetrating SAR images"

Target detection in foliage-penetrating (FOPEN), ultrawideband synthetic aperture radar (UWB SAR) images is a challenging problem. Given the low signal-to-clutter ratio, conventional detection algorithms perform poorly in FOPEN SAR images. Using symmetric alpha-stable (SαS) densities to model the impulsive noise, we have developed a region-adaptive automatic target detection (ATD) algorithm. The image is first segmented, and the resulting labeled image is exploited by a region-adaptive target detection algorithm. We evaluate the performance of the algorithm in different frequency bands, and determine which subbands are useful for image segmentation and target detection [C379]

## "Multichannel antenna systems for radiation of high-power ultrawideband pulses"

To realize attractive possibilities of ultrawideband (UWB) radars, it is necessary to develop multichannel antenna systems for radiation and control by characteristics of high-power electromagnetic pulses localized in space and time. In this paper, new results of single combined antenna investigations are presented. However, the main consideration is given to the investigation of interaction of combined radiators and plane electrical monopoles in linear arrays including the investigation under conditions of steering by the wave beam. Possibility to synthesize the electromagnetic pulse in free space in order to expand radiation spectrum has been investigated theoretically [C380]

## "Ultrawideband sea clutter: system and measurements at X-band"

This paper presents a system description, along with data examples, for an ultrawideband instrumentation radar which has been used by the Radar Division of the Naval Research Laboratory to measure low grazing angle sea clutter at X-band frequencies (3 cm wavelength). The radar system employs a video impulse excited traveling wave tube (TWT), dual wideband horns and multiple head, digital sampling oscilloscope circuitry. In its highest resolution mode, the system utilizes sub-nanosecond transmit pulses (0.15 ns, 3 dB pulsewidth) at a 9 GHz center frequency to achieve resolutions as fine as 2 cm in the range dimension. Multiple resolution waveforms, combined with dual polarization, provide insights into the varied and dynamic character of the radar sea clutter. Upwind data examples, measured at a 4 degree grazing angle in 20 knot winds, are examined [C381]

## "Time and frequency domain algorithms of impulse responses evaluation"

The development of physics and technology of ultrawideband radiation allowed one to radiate into space electromagnetic pulses with a nanosecond duration and power up to 1 GW. The application of such impulses for radar detection of both air and underground objects has been promising. When a received signal is a finite set of digital data, a number of problems concerning the determination of properties of the sounding objects appears.

The conclusions drawn form the investigations are summarised [C382]

## "Autofocus techniques for reducing phase errors in UWB-SAR"

In this paper, the categories of phase errors in UWB-SAR (Ultra-Wideband Synthetic Aperture Radar) are identified at first. Following that, the relationship between phase error magnitude and the level of image degradation is quantified in simplicity. At last, some autofocus techniques are described to reduce space-variant phase errors [C383]

## "Ultra-wideband widebeam SAR processing in the time-space domain"

We propose an ultra-wideband widebeam SAR algorithm for processing in the time-space domain. The proposed algorithm can be interpreted as the time-space domain counterpart of the w-k domain ultra-wideband widebeam SAR algorithms published in recent years. The increased performance of the proposed algorithm against conventional SAR is demonstrated using real data obtained with an ultra-wideband widebeam ground penetrating radar system [C384]

## "A combined detector for UWB SAR target"

VHF/UHF UWB SAR signal is different from traditional narrow band high frequency SAR in that it has its own special properties. A signal model is derived based on these properties of target and clutter. Several target detectors are available in the literature. A new combined detector is provided which carries on the change detection and the two-parameter CFAR detection in two steps. Our simulation results have shown that the combined detector is simple with significant clutter suppression [C385]

## "Toward a theory of ultrawideband sea scatter"

In this work the problem of developing a theory of sea scatter for ultrawideband electromagnetic waves is examined (with special application to radar). The motivation for this work derives from the work of Wetzel, who formulated a scalar, time-domain model of sea clutter and showed that the local curvature properties of the rough surface are an important factor in determining the sources of the scattered return. Here, Wetzel's result is extended to the electromagnetic problem and then extended further to obtain some polarization effects consistent with the small perturbation method [C386]

## "Ultrawideband radar detection of buried objects"

Most commercially available ground probing radars operate in the time domain while the design of a proportion of such radars is based on frequency modulation techniques. This paper briefly considers the two approaches and some of the aspects that define their respective performance. The paper includes a selection of applications to illustrate current capability: detection of explosive mines, detection of the victims of avalanches and archaeological artefacts [C387]

## "An ultrawideband microwave phase shifter"

In this paper, we present a new kind of high-frequency analog phase shifter suitable for ultrawide-band operation. Phase tuning is obtained with a local oscillator (LO) producing two coherent phase-shifted signals which are mixed with the incident radio-frequency (RF) signal. Measurements on a prototype exhibit a 20:1 operational bandwidth. We discuss system design rules and bandwidth limitations [C388]

## "Object form reconstruction at small angle base of ultrawideband radar"

On the basis of generalization of Louis-Boyarsky integral relation including reference fragments for shadow regions of the radar object at a small-angle ultrawideband probing, a method of object form reconstruction from the visible region is suggested. A recursive algorithm for the solution regularization in the presence of measurement noise and a limited frequency band of the pulses used is realized. The efficiency of the method is confirmed by the results of simulation modelling [C389]

## "Scaling of solid state pulsers to high peak power"

The author describes how recent developments in avalanche pulse generator technology now make it feasible to consider designs for systems with peak powers in excess of 1 GW and average powers of several kW. Such systems can be used for ultrawideband radar applications and lend themselves to phased array beam control through simple computer controlled delay of may individual identical modules [C390]

## "Optimisation of the radar for buried object detection"

Radar instruments have become a prospective technology for buried object detection (BOD). Such radars have a specific propagation environment with extremely strong and frequency dependent attenuation and, as a result, short operational range. This fact dictates features of the radar's parameters: wideband signals to provide a high range resolution (fractions of a meter), low carrier frequency (tens or hundreds MHz) and high energy budget (100-130 dB system performance (SP) for 10 ms integration time) to overcome signal attenuation. The requirements of having a wideband ranging signal and a low carrier frequency are partly in contradiction. As a result, ultrawideband (UWB) signals are used. The major goal of this paper is to examine the UWB low frequency pulse compression radar with fractional bandwidth BF>1 for BOD from the position of performance analysis and optimisation and present some practical results [C391]

## "Design of high PRF ferrite-loaded pulse sharpening devices"

Ultrawideband radar (UWB) systems require a pulse generator to drive the antenna. The required pulse repetition frequency (PRF) for UWB systems is typically 1-30 kHz. Pulse generators with thyratron or FET switching can meet the PRF requirement, but develop relatively slow output rise-times of 2-20ns. One approach is to combine such a high PRF pulse generator with a pulse-sharpening device. The Cardiff University group has produced a design of ferrite-loaded coaxial line pulse sharpener with a flowed water dielectric layer/coolant. The line is driven with a 10 kV, 2.5 ns input pulse at 0-30 kHz (or 60 kHz in burst mode), and produces a constant 8 kV, 150 ps rise-time output pulse. This order of PRF is thought to be a unique capability for any sub-ns rise-time, kV level pulser system. The structure of the line is outlined in comparison with a line based on small ferrites and a heatshrunk dielectric layer. The centre conductor contains a set of channels which provide an additional path for coolant flow. The centre conductor also provides mechanical support for the ferrite bead. The ferrite beads are a NiZn grade with high saturation (0.45 T) and low coercivity (50 A/m) [C392]

## "Dispersive distortion of high-frequency ultrawideband signals propagating in near-to-Earth space"

The dispersive distortion of ultrawideband signals in plasma (in ionosphere) is investigated. It has been shown that this distortion can be significant and must be taken into account for remote radio sounding. [C393]

## "Multiband phased-array antenna with interleaved tapered-elements and waveguide radiators"

Multiband, multibeam, phased array antennas are required for today's multi-function radar and communication applications. These types of antennas play a major role in the shipboard and airborne environment, where space is limited. A single antenna is now asked to perform multiple functions, including long-range surveillance, navigation, weapons control, tracking and recognition, and electronic warfare support measures. A phased array antenna capable of covering several different frequency bands in a common aperture is highly desirable, and is currently being pursued for many of these applications. A number of multiband radar antenna configurations have been proposed in the past. An ultra-wideband phased array antenna design using interleaved waveguide elements and wideband tapered elements is presented. This phased array antenna can operate over at least three frequency bands. Numerical results of the aperture match for both types of radiators, including mutual interaction, are presented [C394]

## "Fiber-optic control of a two-dimensional, true time-steered array transmitter"

The use of fiber optic control for phased array radar promises to reduce or eliminate many of the traditional problems associated with these systems such as excessive weight and size and susceptibility to electromagnetic interference. More importantly, optical control techniques are currently the only methods capable of enabling the use of true time-delay beam steering which allows for a wide instantaneous bandwidth and squint-free operation. We describe a two-dimensional, fiber-optic, true time-delay control system capable of squint-free steering of an ultrawideband array. The system demonstrates independent ±30° azimuth and ±30° elevation steering of a 4Ч4 array of flared-notch elements over a 6 to 18 GHz bandwidth. We believe this is the first demonstration of a system with such capabilities. Also, the design of the demonstrated system allows for transitioning to larger, real-world ultrawideband array transmitters [C395]

## "Behavior of ultrawideband-radar array antennas"

This paper discusses general issues concerning ultrawideband (UWB) arrays and specifically analyzes time-delay scanning linear arrays of thin dipoles that are excited by a single-cycle sine, when the effects of mutual coupling are neglected. In particular, when the array consists of eleven equally spaced and equally weighted dipoles, the time-domain radiated far field for broadside scan and the energy-density pattern for several scan angles are determined as a function of the observation angle. Also, the beamwidth is defined in terms of the

energy-density pattern and is calculated versus different scan angles for selected inter-element spacings [C396]

## "Ultra-wideband ground-penetrating radar for the detection of buried metallic mines"

The suitability of ultra-wideband ground-penetrating radar as a tool for the detection of buried, metallic mines is explored. The analysis centers around a 200-800 MHz, dual-polarized ground penetrating radar (GPR) designed and built by SRI International. The analysis consisted of fusing the images from the dual polarizations into a single image to enhance the target objects and suppress clutter. Results are shown for several variations of a Mahalanobis-based fusion technique, and “soft decision” minefield detection results based upon Monte Carlo statistical techniques are also presented. Although relatively few scenes were analyzed, these results show that the dual-polarized GPR is potentially very effective at finding buried mines and minefields [C397]

## "The P-3 ultra-wideband SAR: description and examples"

Under the Advanced Research Projects Agency (ARPA)/ASTO sponsorship, through a contract from the Naval Air Warfare Center (NAWC), the Environmental Research Institute of Michigan (ERIM) has developed an ultra-wideband (UWB) very high frequency (VHF)/ultrahigh frequency (UHF) fully polarimetric airborne synthetic aperture radar (SAR) for studying the detection of foliage-obscured objects. The radar is installed in the NAWC P-3 testbed aircraft and takes advantage of existing ERIM-built multimode, fully-polarimetric X/L/C-band SAR hardware. This paper describes the radar and presents some examples of its capabilities including polarimetric imagery and two-pass interferometric surface height estimates [C398]

## "Ultra-wideband impulse radar"

The requirement for improved performance, in terms of range resolution and target identification, for a range of radar applications, has led to a special category of radar system design. Ultra-wideband radar use a variety of modulation methods such as impulse, FMCW, step frequency, phase coded, etc., but all share the common feature of operation at very high percentage bandwidths, that is, greater than 25% and often 100%. A family tree of the various design approaches is shown. In the case of a radar using an impulse as its excitation, this bandwidth is the instantaneous bandwidth, as opposed to the case of an FM chirp, for example, where the signal is swept through the bandwidth at a rate determined by the radar performance requirements. There are special considerations which apply to ultra-wideband radar systems and in particular impulse radar systems and these fundamentally relate to the fact that whereas the narrowband radar system and hence analysis treats most quantities in terms of power and hence phase information is lost, the wideband radar deals with actual voltages and hence phase information is retained [C399]

## "Aircraft identification using a multi-stage fuzzy neural network"

The effectiveness of time-frequency representation of ultra-wideband radar target signatures, in conjunction with a multi-stage fuzzy neural network (MSFFN), is investigated in the context of aircraft identification. Experimental results on the backscattered data of six aircraft models show that a good level of identification rate is possible at signal-to-noise ratios (SNR) as low as 5 dB [C400]

## "Backscatter characteristics of buried targets measured using an ultrawideband polarimetric random noise radar"

The University of Nebraska has developed a unique ultrawideband polarimetric random noise radar for subsurface probing applications. The radar system was used to measure the backscatter characteristics of buried metallic as well as non-metallic objects which primarily mimicked the sizes and shapes of land mines. These objects were buried in a specially designed sand box at different depths and relative orientations. The data collected on a variety of targets are expected to be useful in developing target detection and discrimination algorithms using this novel radar system [C401]

## "An ultrawideband imaging radar for sea surface studies"

An ultrawideband imaging radar for the study of the surface disturbances caused by submerged mines is described. The system uses an extremely short pulse (0.2 ns, 40% bandwidth) for range resolution and time-domain beamforming for azimuthal imaging. The system also employs a “pulse pair” algorithm for the estimation of surface velocity [C402]

## "Detection of obscured targets in heavy-tailed radar clutter using an ultra-wideband (UWB) radar and alpha-stable clutter models"

The use of an ultra-wideband (UWB) synthetic aperture radar (SAR) for detection of buried or obscured targets is an intense area of research because of the penetration and high-resolution capabilities of the radar. We address the important question of clutter modeling. More specifically, we examine the clutter observed from a forest for robust detection of targets that are buried in a forest environment and obscured by foliage. The observed clutter is a highly impulsive random process that can be accurately modeled with the previously proposed class of alpha-stable processes. Although these α-stable distributions also accurately model the behavior of impulsive sonar sea clutter and impulsive noise in a communication channel, we examined only the performance of a receiver for detecting targets in radar clutter based on alpha-stable distributions via extensive testing on real data, and we compared the performance of receivers based on more popular clutter distributions, such as the K and the Gaussian. The results show that, at sufficiently low probability of false alarm rates, the receiver based on the alpha-stable distribution outperformed the K- and Gaussian-based receivers [C403]

## "A quad channels large capacity data acquisition system for millimetre-wave fully polarized radar"

The authors describe a quad channels, high speed, large capacity storage, high resolution data acquisition system used in automatic millimetre-wave radar full polarization target recognition system (ATR). Millimetre-wave high resolution radar (HRR) target recognition is an interesting research area for fully polarized radar data acquisition. The system described achieves 20 mega sample per second conversion rate. The system includes six sections: quad channels high independent buffer amplifier, quad monolithic high resolution analog-to-digital converters, logic control circuit, data buffer memory, high transfer rate interface, and data acquisition software. High speed, high resolution and integral nonlinearity are the main technical features [C404]

## "Features of ultrawideband radar projecting"

The article presents a new approach to ultrawideband (UWB) radar projecting. Some advantages of such radars are shown in comparison with common narrowband radars and some features of UWB radars are considered, which do not allow the use of traditional methods. New methods of UWB radar characteristics calculation and radar systems projecting are suggested. It discusses the range equation, passive interference protection, radar detection, radar signal processing and EMC. An experimental investigation is also included [C405]

## "Polarimetry in ultrawideband interferometric sensing and imaging"

`Ultrawideband (μHz-PHz) interferometric sensing and imaging polarimetry' has become an indispensable tool in wide area environmental surveillance of the terrestrial and planetary covers. It allows dynamic optimal image feature extraction of significant characteristics of desirable target and/or target sections with simultaneous suppression of undesirable background clutter/speckle at hitherto unknown clarity and of never achieved quality. Ultrawideband may be adopted to the detection, recognition, and identification (DRI) of any stationary, moving, or vibrating target versus arbitrary stationary, dynamically changing or moving geophysical environments. A comprehensive overview is presented on how these modern high resolution/precision complete polarimetric coregistered signature sensing and interferometric POL-SAR imaging techniques, complemented by full integration of novel navigational electronic tools, such as DGPS, will advance electromagnetic vector wave sensing and imaging towards limits of physical realizability. Various examples utilizing NASA-JPL/AIR-SAR, NAWC/P3-POL-SAR, DLR-OPH/DO-POL-SAR airborne, ERS-1, JERS-1 satellite and SIR-C/X-SAR shuttle imaging data sets dealing with the recent Mississippi-Missouri/USA 1993 and Werra/FRG floods and various earthquake surface deformation events will be presented for demonstrating the utility of WISIP [C406]

## "An ultrawideband microwave-radar conceptual design"

The paper outlines the special considerations that characterize the design of an UWB radar for the detection of low altitude missiles over the sea. It discusses the factors which enter into the choice of frequency, and the selection of the transmitter, antenna, and receiver. Reviewed are signal processing issues concerning detection of UWB signals in noise and clutter, non-Doppler MTI based on the pulse-to-pulse change in range due to target motion, measurement of target height based on multipath time delay, and target recognition. The chief limitation of UWB radar that must be overcome before applications are viable is its poor electromagnetic compatibility (EMC) [C407]

## "Determination of radar target scattering center transfer functions from measured data"

Development of successful radar target discrimination schemes using ultrawideband signatures hinges on an accurate understanding of the scattering behavior of complicated radar targets. In the time domain, a target response consists of an early-time component, which is localized and specular in nature, followed by a late-time natural mode series describing the global characteristics of the target. The temporal shape of specular responses depends on the localized geometry of the target; the sharp edge of an aircraft wing will produce a different event

than the curved edge of a fuselage. This paper describes a simple technique for determining the localized transfer functions of a target from its measured time or frequency-domain response [C408]

## "Ultrawideband foliage penetration measurements"

Ultrawideband radar measurements of targets obscured by foliage were performed on the Radar Comparison Program, an effort funded by Advanced Research Project Agency (ARPA) and administered by Battelle Pacific Northwest Laboratories. Program objectives included collecting ultrawideband synthetic-aperture radar (SAR) data for use in analysis of foliage penetration at ultrahigh frequencies (UHF), and performing experiments to quantify phenomena important to foliage penetration, such as attenuation and backscatter [C409]

## "Distortion of transient pulsed fields in propagation above a highly refractive half-space"

Both electric and magnetic current sources are considered. The technique is based upon the exact image theory developed by Lindell and Alanen (1984). A computational technique, valid where the refractive index of the medium is large, is accurate over a wide range of frequencies, particularly at grazing incidence. The formulae can be written in terms of the complementary error function of a complex argument. Although closely related to the surface-wave expansion, the formulae derived are valid for all angles and in the far-field reduce to the reflection coefficient method (RCM). The efficiency of this computational technique allows the practical use of frequency domain analysis for the reflection of transient pulses. Example calculations are provided using a Gaussian current pulse, and the validity of the RCM is discussed. Regimes in which significant distortion of a transient pulse occurs are identified [C410]

## "Some analytical results for the propagation and spreading of short electromagnetic pulses in the ionosphere"

Some general results based on evaluation of the temporal moments of a pulse are examined for wideband pulses and compared with the narrowband approximation. Particular attention is given to factors which affect pulse spreading in an underdense collisionless magnetoplasma [C411]

## "Broadband aerodynamic antennas for the Advanced Radar Missile Scorer (arms)"

The authors' company developed the Advanced Radar Missile Scorer to the terminal trajectory of anti-aircraft missiles from droned target aircraft. The original system utilised resistively loaded conical antennas which had adequate electrical performance but were unsuitable for a supersonic target. These antennas were developed into an aerodynamic double blade antenna for US Navy trials on the QF4. They are being miniaturised with modifications to the transmitter to maintain performance at lower production cost [C412]

## "Some numerical predictions of the attenuation and dispersion of short VHF and UHF pulses between ground level and 500 km altitude"

This paper reports the results of a study of short pulses (typically less than ten cycles) with carrier frequencies in the range 30 MHz-1 GHz. The results were generated by a particularly simple model in which ionospheric anisotropy is ignored (since the frequencies and bandwidths considered are large compared with typical electron gyrofrequencies) and only vertically-launched plane waves are considered. Quantitative predictions of pulse spreading are presented, and several possible extensions of the model are described briefly [C413]

## "Broadband quasi-optical mode converters for high power microwaves"

The electron cyclotron maser is a high-power step-tunable MM-wave source which produces conical TEomnradiation distributions with complicated E-field structure and usually no field on the waveguide axis. For nearly all applications, which include radar systems, plasma heating by ECRH and plasma diagnostics, a well defined plane polarized pencil beam is required. Quasi-optical mode converters of the Vlasov (step-cut) or Nakajima (obliquely-cut radiator) type can be used to convert the TEomnoutput modes of the maser into a highly directional pencil beam. In applications this would allow the frequency of operation to be varied without need to change physically the mode conversion system [C414]

## "Very-short pulse propagation at millimetric wavelengths through the atmosphere"

A technique first developed by Forrer (1958), in which the atmospheric channel transfer function is approximated by a truncated polynomial function of frequency, has been extended (IEE Proc. H vol.137, p.304-10 of 1990) to include both absorption and dispersion at these wavelengths. The technique has been used to examine a variety of broadening or compression, the shift in mode frequency of the received pulse, and the superposition of a

modulation (or `chirp' frequency) [C415]

## "Advanced technologies for ultra wideband system design"

The author presents a summary of the ultrawideband (UWB) concept, clarifying its instantaneously large percent-bandwidth nature and the inseparability which results in its four-dimensional ambiguity function. In conventional design, this coupling is suppressed. However, evidence is presented that suggests that there may be unique performance and EMC (electromagnetic compatability) advantages to be gained from exploiting this coupling. It is explained why this improved performance is not attainable using switch-based transmitters. Attention is given to the use of a programmable function generator (e.g., a direct digital synthesizer) to generate the required UWB waveform and to the exploitation of localized wave solutions to Maxwell's equations for their contribution to improved resolution and reduced path loss [C416]

## "Laboratory studies of the spectral properties of sea spikes"

An experimental system used to study the spectral content of sea spike echoes generated in a wave tank is described. Some illustrative data are presented. The objective is to determine the spectral evolution of radar returns from a disturbed water surface and to relate any spectral changes to changes in the geometry of the surface feature responsible for the backscatter, thereby determining the dynamic transfer function for surface scattering events. In order to obtain high resolution radar data and water surface geometry data simultaneously, a two-channel, ultrawideband radar based on a microwave time-domain reflectometer (TDR) is used in concert with a scanning laser slope gauge (SLSG). Data from these experiments are presented to illustrate the dynamic nature of the sea spike transfer function. [C417]

## "IEE Colloquium on `Antenna and Propagation Problems of Ultrawideband Radar' (Digest No.004)"

The following topics were dealt with: ultrawideband radar systems, wavelet processing and impulse radar technology; aerodynamic antennas, TEM horns and quasi-optical mode convertors; short-pulse attenuation, dispersion and distortion [C418]

## "Generation and application of moderate power, ultra-wideband or impulse signals"

The author discusses methods of generating very short risetime pulses using linear and nonlinear, optically initiated semiconductor switches, transit time delay diodes, and unique circuit configurations. The development of very fast (tens of picoseconds), moderate voltage, (1-20-kV) electronic switches based on optically initiated and transient impact ionization processes in semiconductors has made possible a number of applications of short (tens to hundreds of piceseconds) electromagnetic pulses. These applications include high-resolution, time-domain radar, all-semiconductor, short pulse laser sources, compact high pulse rate lidar systems, and high-resolution imaging and identification [C419]

## "Wavelet processing of ultra wideband radar signals"

UWB radar response functions are dominated by singularities in the target impulse response, and the characterisation and localisation of these singularities constitute the best approach to signal detection and identification. This paper presents an introduction to the fast wavelet transform algorithm and demonstrates its ability to isolate features in UWB signals. It illustrates the application of wavelets to UWB signal analysis by using finite difference time domain predictions of radar scattering from canonical objects and experimental data from the time domain rear facility at DRA Malvern [C420]

## "Velocity matched filtering/coherent integration of ultrawideband pulse trains"

The development of optically activated semiconductor switches has advanced to the point where they are ready for implementation in radar systems. Extended detection range is possible when the switch is operated at high pulse repetition frequencies combined with integration of multiple pulse returns. Coherent integration of the returns from moving targets is described, based on real signal processing instead of analytic signal derivation, with velocity as the observable. The performance of this approach is quantified [C421]

## "Simulation of target responses to high frequency ultra wideband radar signals using the physical optics impulse response"

High-frequency ultrawideband radar signals are constructed by modulating a microwave or millimeter wave carrier with a broad bandwidth signal with the percentage bandwidth of the modulating signal being typically more than 20% of the carrier frequency. The wideband properties of the signal render the single-number radar

cross section (RCS) inadequate for target response simulations. Instead, a characteristic function describing the response of the target to the waveform must be obtained in either the time or frequency domain. A first approximation to the temporal impulse response of a target can be obtained from physical optics (PO). The target's response can then be obtained by convolving the signal with the temporal impulse response of the target. A computational method for obtaining a PO signal response is described, and the results are compared to analytic responses for some primitive volumes (flat plate, cone, sphere) [C422]

## "The current status of research into ultrawideband radars in Russia"

The utilization of ultrawideband signals solves at a new qualitative level the important problems of radar observation: measurement of target coordinates and characteristics, discrimination and radar imaging. A survey of the description methods of UWB signals and radar performance including details of peculiarities of modeling, forming, radiation, scattering, and reception of UWB signals and their processing techniques is presented [C423]

## "Developments in impulse radar technology for surface penetrating radar"

After a detailed evaluation of various options it was concluded that the continuously loaded resistive dipole or monopole offered the best performance in terms of radiated pulse shape, and this configuration was adopted as a standard. Such an antenna has a resistance which increases exponentially as a function of length, and the choice of the start point resistance, element length and taper profile all affect the results [C424]

## "Wavelet decomposition of UWB radar signals"

It is shown that wavelet transform of UWB (ultrawideband) radar signals at different scales can be used to identify the geometrical features of target scattering components. The number of scatters and their location, and the geometry of each scatterer are parameters that can be estimated from the wavelet representation of the target impulse response [C425]

## "VHF/UHF ultra-wideband SAR imaging of scattering targets in foliage"

The radar response of foliage at selected narrow band has been studied and statistically modeled, while the wideband response behavior is not as well known. Measurements were taken of a medium-sized woodlands with a basal area of 106 ft2/acre, in a bandwidth from 200 MHz to 2000 MHz. The woodland was located in a temperature climate, and consisted of 100% deciduous vegetation. The data were taken in both summer and autumn. The autumn measurements were done with an estimated 10% of leaf coverage. Corner reflectors were placed into the target range to study absorption. Coherent focused images are generated using an adaptation of a projection slice algorithm. Since the resolution is on the same order as the effective center frequency, the polarity of the focussed image is meaningful. Waterfall plots and synthetic aperture radar images have been obtained [C426]

## "Feasibility of Ultrawideband Radar"

First Page of the Article [C427]

## "VHF/UHF ultra-wideband measurements of scattering targets in foliage"

Summary form only given. A system was designed to investigate several performance parameters of UWB (ultrawideband) foliage penetration and radar scattering in the VHF-UHF frequency range. The goals of the experiment included: (1) a study of UWB radar propagation through foliage, including both attenuation and dispersion of this coherent wideband energy; (2) a study of the clutter scattering from the woods under wideband coherent illumination; (3) a study of the distortion in the target impulse signature caused by interactions with nearby trees and foliage; and (4) a study of seasonal and possibly diurnal changes for the UWB case. The system used the Big Ear radio telescope as a support structure for SAR (synthetic aperture radar) images. Coherent SAR images were generated for the woods with several targets included in the scene. The data provide information over 200 MHz to 2000 MHz and for HH, HV, and VV polarizations [C428]

## "Ultra-wideband polarimetric imaging of corner reflectors in foliage"

An ultrawideband imaging radar was developed. It is a highly mobile, ground-based system capable of 2D and 3D imaging at very close ranges to a synthetic aperture. The radar is fully coherent over two bandwidths (0.1 to 2 GHz and 2 to 18 GHz) and is being used for target and for foliage penetration measurements. The emphasis of the program is to characterize the radar phenomenology associated with the detection and classification of targets in foliage. An important objective is to identify the radar parameters needed by an operational airborne

foliage penetration synthetic aperture radar. Polarimetric measurements of 8-ft trihedral corner reflectors deployed in the woods at Lincoln Laboratory were performed during the summer of 1991. Measurements were taken at 0.3-1.0 GHz with a single, linearly polarized log-periodic antenna, and at 1-2 GHz with a dual-polarized quad-ridged horn antenna [C429]

## "Wideband polarimetric radar imaging"

Summary form only given. The relationship of the polarization dependence of the corresponding radar cross-section matrices in the frequency domain with that of the target eigen-resonance maps is demonstrated, leading to the concept of polarimetric wavelets, which offers a useful interpretative tool for polarimetric UWB (ultrawideband) target versus clutter discrimination and analysis. Utilizing available sets of multiband continuous wave spectral polarimetric scattering matrix data sets in the (30) 300 MHz to 3 (30) GHz region, the authors demonstrated the relevance of a `polarimetric extension' of the UWB impulse radar approach with the specific aim of identifying the important wide-ranging applications of future UWB (non-carrier frequency) polarimetric impulsive radar (POL-RAD) synthetic aperture radar (POL-SAR), and inverse synthetic aperture radar ISAR (POLISAR) systems not only to low-radar cross section-target analysis but even more so to under-burden (foliage/poorly conductive media) penetration for detecting hidden conducting objects (tanks, mines, etc.) in wide area site/environmental security monitoring [C430]

## "Target material characterization using high-order signal processing of ultra-wideband radar data"

Results obtained by two high-order signal processing methods applied to ultrawideband (UWB) radar data in the UHF band are described. The UWB radar data were collected in a specially designed bistatic test range. Four types of UWB signals were used to test a metal (reference) plate, five different commercially available radar absorbing material samples with metal backing, and five natural material (clutter) samples. The objective was to assess the potential of the authors' UWB signal modalities and associated signal processing techniques in extracting reliable and distinct characterizations of different target materials. Pseudorandom UWB radar waveforms were used, and the collected data were analyzed using two high-order spectral processing (HOSP) methods: bispectral analysis and Kernel analysis. The radar problem was cast in a black-box system identification context, allowing the interpretation of the obtained results as a system/target identifiers and the use of the HOSP techniques in this context. The preliminary results demonstrate the feasibility of this radar technology and processing methodology and provide intriguing possibilities in utilizing this approach for target/material characterizations [C431]

## "Target description using wavelet transform"

A method for characterizing radar signatures using the wavelet transform is developed based on the principle of scattering centers. The adopted target representation is based on the colored bright spot approach, which is closely related to wavelet analysis. It is shown how to estimate the number, location, level of integration or differentiation, and scattering intensity of point scatterers using wavelet decomposition. The proposed target analysis method is tested using experimentally measured radar signals [C432]

## "The generation of high energy ultra wide band pulses"

The authors present a theoretical discussion of the performance of photoconductive switches mounted in a matched transmission line structure. The issues of risetime and power density are addressed. They define a switch performance parameter, α, which results in a recipe for optimizing the performance of photoconductive switches. This parameter, which is related to the power produced per unit width of the system and the pulse risetime, shows that, in the high-speed regime, there is no simple trade-off for power and speed, and that high-performance operation necessitates high switch current density, i.e. low impedance and linear operation. The authors also discuss the limits on α due to materials' properties and conclude with a discussion of experimental life-testing and a comparison between the theory and experimental results [C433]

## "CARABAS-an UWB low frequency SAR"

The significance of low-frequency ultrawideband (UWB) radar imagery has been investigated. In order to verify the theoretical predictions, an airborne SAR (synthetic aperture radar) system, operating over the frequency band 20-90 MHz, has been developed. CARABAS (coherent all radio band sensing) adopts a major part of the shortwave radio band for the transmission and reception of UWB signals. As a result, the system has a high geometric resolution, in particular in relation to the emitted wavelengths. A first data collection campaign took place in January 1992; initial data are still in the phase of evaluation. In the wavelength interval adopted, vegetation is transparent and radiation penetrates the ground to a significant degree. The system is considered capable of mapping structures and objects obscured by vegetation or buried in the ground [C434]

## "Experimental investigation on ultra-wideband radar characteristics of coating RAM's targets"

The authors have built a system of impulse radar, and made experimental investigation of a RAM coating on the surface of metallic targets, recording their echo signal data, evaluating the impulse response of the targets, and computing the energy of scattering echo and the power spectral density. The results show that ultrawideband radar has good capabilities to combat the RAM compared with the narrowband radar [C435]

## "Status of ultrawideband (UWB) radar and its technology"

UWB radar is of interest because of its highly successful application to ground probing radar and to the challenge of working in an area which requires technology different from more conventional narrowband (NB) radar. The status of UWB technology is examined, and differences between UWB and NB radar are discussed with reference to the transient nature of target scattering, dispersive propagation effects, antenna effects, transmitters, and signal processing [C436]

## "Selected sea clutter and target measurements with a 0.2-1.0 GHz ultra-wideband radar"

To explore the potential of UWB (ultrawideband) radar for over-the-ocean surveillance applications, a program was begun at the Naval Ocean Systems Center (NOSC) to design and assemble an UWB radar in 1991 at a test site located along the Pacific Ocean near San Diego. The source generated a pulse with a 0.5-ns pulsewidth and a 0.2-ns risetime, yielding a waveform with energy concentrated in the 0.2-1.0-GHz portion of the spectrum. The radar and a few of the first measurements with it are described. In particular, calibrated measurements of sea clutter made over a bandwidth of 0.2-1.0 GHz are reported [C437]

## "Ultra-wide bandwidth, multi-derivative radar systems"

The potential applicability of multiderivative, localized wave (LW) arrays to radar and to other remote sensing systems is analyzed. The analysis includes the effects of having a target within the extended near-field region of an LW array. In particular, an electrically short (nonresonant) dipole transmitter-receiver system is chosen to illustrate the results because it is one of the simplest examples of a system whose output signals are related to the input driving functions by several time derivatives. Because of the different time derivatives involved, different portions of the frequency spectra of those signals will control the associated beam characteristics. Thus, a set of ultrawide bandwidth signals and an electromagnetic transmitter-receiver system can be designed to realize enhancements of a particular beam parameter. The LW solutions simply provide immediate access to this situation. The transmitter/receiver system configuration then becomes extremely important if enhanced performance is desired, and it must be tailored to the particular beam parameter of interest. Preliminary comparisons between an LW pulse driven array system and the corresponding conventional continuous wave system illustrate these results [C438]

## "UWB waveforms and coding for communications and radar"

The author describes the efforts of Time Domain Systems Incorporated (TDS), a small company specializing in the development of RF monocycle waveform applications. the areas of application are primarily short-range communications and radar. Monocyclic RF is a subset of ultrawideband (UWB) electromagnetics. UWB signals are defined as having greater than 25% relative bandwidth as defined by BW/fc . Single RF cycles easily qualify with bandwidths of approximately 100% TDS's focus is on RF monocycles with periods from a few nanoseconds down to tens of picoseconds, corresponding to centre frequencies of 200 MHz to 20 GHz [C439]

## "Ultra-wideband radar-potential and limitations"

Some of the more obvious uses of ultrawideband (UWB) radar are discussed, together with some of the problems (arising from limited source capabilities) in implementing adequate designs. It is pointed out that the primary limitation on such systems is the lack of peak output power. Previously, the pulse sources for these radars have been either transistor impulse generators or spark gaps; both of these sources have severe limitations. With the development of OASS devices, new possibilities for extending the performance of UWB radars become available. In particular, the repeatability and fast risetime of OASS devices, while operating at high power levels, are of extreme importance to this radar technology [C440]

## "Ultrawideband radar"

The author discusses the characteristics of ultrawideband radar and makes qualitative comparisons with narrowband systems. He notes that ultrawideband radars use signal bandwidths greater than 25% of center

frequency. Conventional radio and radar signal bandwidths are generally less than 1% of center frequency. Using ultrawideband signals gives a range resolution smaller than most military targets. It is further pointed out that ultrawideband impulse signals can provide a capability for target imaging and identification through resonance characteristics. The added capabilities gained through ultrawideband signals are balanced by needs for complex receiver and signal processing [C441]

### "W-Band Transmitter Upgrade for the Haystack UltraWideband Satellite Imaging Radar (HUSIR)"

MIT Lincoln Laboratory is building W-band (94 GHz) radar for the Haystack Observatory Radar in Westford, Massachusetts. Designated the Haystack ultra-wide band satellite imaging radar (HUSIR), the new transmitter will improve resolution almost ten-fold in support of the observatory's space surveillance program. Diversified Technologies, Inc. (DTI) received a contract in July 2004 for the design and construction of the radar's new transmitter. This paper provides an overview of the transmitter design, key technical drivers, the VED (gyroklystron and gyro-TWT) interfaces, and a summary of the progress, including installation and testing of the transmitter in 2006 [C442]

### "Shielding, Radioabsorbing and Scattering Materials for Decreasing of Disturbances and for Enhance of Efficiency of Radar Work"

Georadar of OKO-M1 type working at 400 MHz central frequency in combinations with different type of radioshielding and scattering materials have been studied to determine a possibility of an improvement of noise immunity and functional characteristics of georadar at various conditions. A number of experimental georadar covers of several types based on radioshielding, radioabsorbing and scattering materials has been produced and tested. The investigations have confirmed the fact that usage of a shielding cover is useful both for suppression of interference with up-land objects and for decrease of aerial disturbances. We found that such georadar cover can decrease a level of the aerial interference disturbance up to 30 dB, and undesirable signal reflected from a metal object placed near over georadar can been decreased on a value of 15...23 dB. A scan picture becomes more clean and readable when georadar shielding cover is used [C443]

### "The Quantitative Analysis of Ground Penetrating Radar"

A method for presenting the result of ground penetrating radar (GPR) data processing in the form of structural model of the medium being probed that is obtained on the basis of the quantitative analysis of radar traces showing the reflecting boundaries and electrophysical parameters is considered in this paper. The basis for the method developed are results of studying the features of the reflected signal formations in in-homogeneous media. The method enables to algorithmize the construction process for the structural model of the model of the medium being probed, to decrease labour consumption for radar trace processing and to reduce human factor effect [C444]

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