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Chapter 1 : ARTECH HOUSE USA : Principles of High-Resolution Radar

*Principles of High-Resolution Radar (Artech House Radar Library) [August W. Rihaczek] on calendrierdelascience.com *FREE* shipping on qualifying offers. This re-lease of the classic text examines step-by-step the development of radar resolution theory.*

The defocus kernel of this lens is designed to preserve high frequencies over a wide depth range. An all-focused image processed from the lattice-focal lens input. Since the defocus kernel preserves high frequencies, we achieve a good restoration over the full depth range. Depth of field DOF , the range of scene depths that appear sharp in a photograph, poses a fundamental tradeoff in photographyâ€" wide apertures are important to reduce imaging noise, but they also increase defocus blur. Recent advances in computational imaging modify the acquisition process to extend the DOF through deconvolution. Because deconvolution quality is a tight function of the frequency power spectrum of the defocus kernel, designs with high spectra are desirable. In this paper we study how to design effective extended-DOF systems, and show an upper bound on the maximal power spectrum that can be achieved. We analyze defocus kernels in the 4D light field space and show that in the frequency domain, only a low-dimensional 3D manifold contributes to focus. Thus, to maximize the defocus spectrum, imaging systems should concentrate their limited energy on this manifold. We review several computational imaging systems and show either that they spend energy outside the focal manifold or do not achieve a high spectrum over the DOF. Guided by this analysis we introduce the lattice-focal lens, which concentrates energy at the low-dimensional focal manifold and achieves a higher power spectrum than previous designs. We have built a prototype lattice-focal lens and present extended depth of field results. Abstractâ€"A theoretical model that describes the power of a scattered Global Positioning System GPS signal as a function of geometrical and environmental parameters has been developed. This model is based on a bistatic radar equation derived using the geometric optics limit of the Kirchhoff approxi This model is based on a bistatic radar equation derived using the geometric optics limit of the Kirchhoff approximation. Waveforms obtained for aircraft altitudes and velocities indicate that altitudes within the interval 5â€"15 km are the best for inferring wind speed. In some regimes, an analytical solution for the bistatic radar equation is possible. This solution allows converting trailing edges of waveforms into a set of straight lines, which could be convenient for wind retrieval. A transition to satellite altitudes, together with satellite velocities, makes the peak power reduction and the Doppler spreading effect a significant problem for wind retrieval based on the delay-map-ping technique. At the same time, different time delays and dif-ferent Doppler shifts of the scattered GPS signal could form rela-tively small spatial cells on sea surface, suggesting mapping of the wave-slope probability distribution in a synthetic-aperture-radar SAR fashion. This may allow more accurate measurements of wind velocity and wind direction. Index Termsâ€"Bistatic rough surface scattering, sea surface re-mote sensing. Show Context Citation Context Some numerical and empirical results for the WAF are known in literature cf. Here, we assume a simple model for , which relies on its analytical behavior along the temporal and frequency axes. Indeed, at transforms into a known function [12] 20 The triangular shape of thi Product high-order ambiguity function for multicomponent polynomial-phase signal modeling by Sergio Barbarossa, Anna Scaglione, Student Member, Georgios B. Identifiability issues arising with existing approaches are described first when dealing with multicomponent PPS having the same highest ord Identifiability issues arising with existing approaches are described first when dealing with multicomponent PPS having the same highest order phase coefficients. This situation is encountered in applications such as synthetic aperture radar imaging or propagation of polynomialphase signals through channels affected by multipath and is thus worthy of a careful analysis. A new approach is proposed based on a transformation called product high-order ambiguity function PHAF. More specifically, it removes the identifiability problem and improves noise rejection capabilities. Performance analysis is carried out using the perturbation method and verified by simulation results. Abstractâ€"In this paper, we present an iterative method for the accurate estimation of amplitude and frequency modulations AMâ€"FM in time-varying multi-component quasi-periodic signals such as voiced speech. Based on a deterministic plus noise representation of speech initially suggested by Laroche Based on a deterministic plus noise representation of speech initially suggested by Laroche et al. Next, we show how this representation can be used for the estimation of amplitude and frequency modulations and provide the conditions under which such an estimation is valid. Finally, we suggest an adaptive algorithm for nonparametric estimation of AMâ€”FM components in voiced speech. Based on the estimated amplitude and frequency components, a high-resolution timeâ€”frequency representation is obtained. The suggested approach was evaluated on synthetic AMâ€”FM signals, while using the estimated AMâ€”FM information, speech signal reconstruction was performed, resulting in a high signal-to-reconstruction error ratio around 30 dB. Signal Processing , " Novel linear algorithms are proposed in this paper for estimating time-varying FIR systems, without resorting to higher order statistics. The proposed methods are applicable to systems where each time-varying tap coefficient can be described with respect to time as a linear combination of a finite The proposed methods are applicable to systems where each time-varying tap coefficient can be described with respect to time as a linear combination of a finite number of basis functions. Examples of such channels include almost periodically varying ones Fourier Series description or channels locally modeled by a truncated Taylor series or by a wavelet expansion. It is shown that the estimation of the expansion parameters is equivalent to estimating the second-order parameters of an unobservable FIR single-input-many-output SIMO process, which are directly computed under some assumptions from the observation data. By exploiting this equivalence, a number of different blind subspace methods are applicable, which have been originally developed in the context of time-invariant SIMO systems. Identifiability issues are investigated, and some illustrative simulations are presented. Pulse compression for weather radars by Ashok S. Abstractâ€”Wideband waveform techniques, such as pulse com-pression, allow for accurate weather radar measurements in a short data acquisition time. However, for extended targets such as precipitation systems, range sidelobes mask and corrupt observations of weak phenomena occurring near areas of stro However, for extended targets such as precipitation systems, range sidelobes mask and corrupt observations of weak phenomena occurring near areas of strong echoes. Therefore, sidelobe suppression is extremely important in precisely determining the echo scattering region. A simulation procedure has been developed to accurately describe the signal returns from distributed weather targets, with pulse compression waveform coding. This procedure is unique and improves on earlier work by taking into account the effect of target reshuffling during the pulse propagation time which is especially important for long duration pulses. The simulation procedure is capable of generating time series from various input range profiles of re-flectivity, mean velocity, spectrum width, and SNR. Results from the simulation are used to evaluate the performance of phase-coded pulse compression in conjunction with matched and inverse compression filters. The evaluation is based on comparative analysis of the integrated sidelobe level and Doppler sensitivity after the compression process. The results from simulation and the data analysis show that pulse-compression techniques indeed provide a viable option for faster scanning rates while still retain-ing good accuracy in the estimates of various parameters that can be measured using a pulsed-Doppler radar. Also, it is established that with suitable sidelobe suppression filters, the range-time sidelobes can be suppressed to levels that are acceptable for operational and research applications. Index Termsâ€”Pulse compression, weather radar. Fetter [3] demonstrated the use of a 7-bit Barker phase-coded transmit pulse and a matched-fi Abstractâ€”This paper presents an analysis of the joint estimation of target location and velocity using a multiple-input multiple-output MIMO radar employing noncoherent processing for a complex Gaussian extended target. A MIMO radar with transmit and receive antennas is considered. To provide insight, we focus on a simplified case first, assuming orthogonal waveforms, temporally and spatially white noise-plus-clutter, and independent reflection coefficients. Under these simplifying assumptions, the maximum-likelihood ML estimate is analyzed, and a theorem demonstrating the asymptotic consistency, large, of the ML estimate is provided. Numerical investigations, given later, indicate similar behavior for some reasonable cases violating the simplifying assumptions. The problem of estimating the phase parameters of a phase-modulated signal in the presence of colored multiplicative noise random amplitude modulation and additive white noise both Gaussian is addressed. Maximum likelihood type estimators that ignore the noise color and optimize a criterion with respect to only the phase parameters are proposed. These estimators are shown to be equivalent to the nonlinear least squares estimators, which consist of matching the squared observations with a constant amplitude phase-modulated signal when the mean of the multiplicative noise is forced to zero. Closed-form expressions are derived for the efficiency of these estimators and are verified via simulations. Physical wavelets are acoustic or electromagnetic waves resulting from the emission of a time signal by a localized acoustic or electromagnetic source moving along an arbitrary trajectory in space. This gives a lo-cal alternative to the construction of such waves in terms of nonlocal plane waves via Fourier transforms. In this tutorial paper we give a brief, self-contained introduction to physical wavelets and apply them to remote sensing. We define the ambiguity functional, a generaliza-tion of the radar and sonar ambiguity functions which applies not only to wideband signals but also to targets and radar platforms executing arbitrary nonlinear motions. Physical Wavelets Physical wavelets were introduced in [1â€”5] and generalized in [6,7]. In this section we give a brief introduction to such wavelets. For simplicity we specialize to acoustic wavelets, which are local scalar solutions of the wave equation in space-time. Electromagnetic wavelets are closely related but somewhat more complicated, since they take into account the vector nature of electric and magnetic fields and the accompanying polarizations; see [5], Chapter 9. The wavelets described here are more general, and at the same time conceptually simpler, than those developed in [5]. They are generated physically when a point source Show Context Citation Context No transversal motion tracking mode: The target moves directly toward or away from the radar site, i. When these assumptions are introduced into Equation 9 , a computation performed in the Appendix g Understanding Discrete Rotations by Michael S. Parks , " The concept of rotations in continuous-time, continuousfrequency is extended to discrete-time, discrete-frequency as it applies to the Wigner distribution. As in the continuous domain, discrete rotations are defined to be elements of the special orthogonal group over the appropriate discrete field As in the continuous domain, discrete rotations are defined to be elements of the special orthogonal group over the appropriate discrete field. Use of this definition ensures that discrete rotations will share many of the same mathematical properties as continuous ones. A formula is given for the number of possible rotations of a prime-length signal, and an example is provided to illustrate what such rotations look like. In addition, by studying a 90 degree rotation, we formulate an algorithm to compute a prime-length discrete Fourier transform DFT based on convolutions and multiplications of discrete, periodic chirps. This algorithm provides a further connection between the DFT and the discrete Wigner distribution based on group theory. For the case of discrete-time, discrete-frequency timefrequency distributions, rotations are more difficult to understand because the time-frequency plane is periodic and has finitely many points.

Chapter 2 : CiteSeerX â€” Citation Query Principles of High-Resolution Radar

Principles Of High-Resolution Radar by August W. Rihaczek This re-lease of the classic text examines step-by-step the development of radar resolution theory. Key topics include the capabilities and limits of radar and the details of radar design.

Share Summary Modern radar and its related topics, architectures, technologies, and applications are covered, from fundamentals to the current state of the art in each area. Surface and airborne radars are described: Conventional and advanced topics are introduced, including ESA and AESA, Auto-calibration of active phase arrays, modern waveforms and tracking, synthetic aperture radar and synthetic wideband, adaptive cancellation and STAP, radar phenomenology, modeling and simulations, key challenges and supporting state of the art technologies. This course is designed to benefit both engineers and technical managers. He has forty one years experience in science and engineering, thirty three of which in radar systems analysis, design, development, and testing for the Navy, Air Force, Marine Corps, and FAA. His experience encompasses many ground based, shipboard, and airborne radar systems. He has been technical lead on many radar efforts including Government source selection teams. He continues to provide radar technical support under consulting agreements. Contact this instructor please mention course name in the subject line Course Outline: Fundamentals, examples, sub-systems and issues Radar Fundamentals: Electromagnetic radiations, frequency, transmission and reception, waveforms, PRF, minimum range, range resolution and bandwidth, scattering, target cross-section, reflectivities, scattering statistics, polarimetric scattering, measurement accuracies, basic radar operating modes. The Radar Range Equation: Development of the simple two-ways range equation, signal-to-noise, losses, the search equation, inclusion of clutter and broad noise jamming Radar Propagation in the Earth troposphere: Solid angle, antenna beamwidths, directive gain, illumination function, pattern, and examples, the radar range equation development, system losses, atmospheric absorption, the Pattern Propagation Factor, the Blake chart, and examples. Noise in Receiving Systems: Thermal noise statistics, relations among voltage, amplitude, and power statistics, false alarm time, false alarm number, probability of false alarm PFA and the detection threshold, the detection probability, detection of non-fluctuating targets, the Swerling models of target fluctuation statistics, detection of fluctuating targets, pulse integration options, the significance of frequency diversity The Radar Subsystems: Transmitter, antenna, receiver and signal processor Pulse Compression and Doppler filtering principles, automatic detection with adaptive detection threshold, the CFAR mechanism, sidelobe blanking angle estimation , the radar control program and data processor Modern Signal Processing and Clutter Filtering Principles: Modern Advances in Waveforms: Fundamental concepts, directivity and gain, elements and arrays, near and far field radiation, element factor and array factor, illumination function and Fourier transform relations, beamwidth approximations, array tapers and sidelobes, electrical dimension and errors, array bandwidth, steering mechanisms, grating lobes, phase monopulse, beam broadening, examples Solid State Active Phased Arrays AESA: Driving issues, types of calibration, auto-calibration via elements mutual coupling, principal issues with calibration via mutual-coupling, some properties of the different calibration techniques. Functional block diagram, what is radar tracking, firm track initiation and range, track update, track maintenance, algorithmic alternatives association via single or multiple hypotheses, tracking filters options , role of electronically steered arrays in radar tracking Surface Radar: Principles of high resolution, radar vs. High Range Resolution via Synthetic Wideband: Principle of high range resolution - instantaneous and synthetic, synthetic wideband generation, grating lobes and instantaneous band overlap, cross-band dispersion, cross-band calibration, examples Adaptive Cancellation and STAP: Adaptive cancellation overview, broad vs. Radar Modeling and Simulation Fundamentals: Key radar challenges, key advances transmitter, antenna, signal stability, digitization and digital processing, waveforms, algorithms Tuition: This course is not on the current schedule of open enrollment courses. If you are interested in attending this or another course as open enrollment, please contact us at or at ati aticourses. ATI typically schedules open enrollment courses with a lead time of months. Group courses can be presented at your facility at any time. For on-site pricing, request an on-site quote. You may also call us at or email us at ati aticourses.

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The development of radar resolution theory is examined in this text. Key topics include the capabilities and limits of radar, the details of radar design, fundamentals of waveform analysis, pulse compression waveforms, coherent pulse trains and detection clutter.

We consider the problem of estimating the parameters of a chirp signal observed in multiplicative noise, i. Two methods for solving this problem are presented. First, an unstructured nonlinear least-squares approach NLS is proposed. It is shown that by It is shown that by minimizing the NLS criterion with respect to all samples of the time-varying amplitude, the problem reduces to a twodimensional 2-D maximization problem. A theoretical analysis of the NLS estimator is presented, and an expression for its asymptotic variance is derived. It provides a computationally simpler but suboptimum estimator. A statistical analysis of the HAF-based estimator is also carried out, and closed-form expressions are derived for the asymptotic variance of the HAF estim Bayesian learning consists of estimating the distribution of the observed data conditional upon each class from a set of training samples. Unfortunately, this estimation requires to evaluate intractable multidimensional integrals. This paper studies an original implementation of hierarchical Bayesian learning which estimates the class conditional probability densities using MCMC methods. The performance of this implementation is first studied via an academic example for which the class conditional densities are known. The problem of classifying chirp signals is then addressed by using a similar hierarchical Bayesian learning implementation based on a Metropolis-within- Gibbs algorithm. Signal Process , " The adaptive OFDM signal yields a better auto-correlation function ACF that results into an improved delay range resolution for the radar system. First, we develop a mutlicarrier OFDM signal model and the corresponding WAF at the output of the matched filter, emphasizing that the received signal depends on the scattering parameters of the target. Then, we devise an optimization procedure to select the OFDM waveform such that the volume of the corresponding WAF best approximates the volume of a desired ambiguity function. We demonstrate the improvement in the resulting ambiguity function, along with the associated ACF, through numerical examples. We find that the optimization algorithm puts more signal energy at subcarriers in which the target response is weaker. Abstract â€” In this paper, we propose a frequency division multiplexing FDM diversity waveform technique to achieve a delay-Doppler response that approximates the composite ambiguity function CAF in a multiple target scenario. First, a channel estimate based on maximum likelihood estimation MLE First, a channel estimate based on maximum likelihood estimation MLE for each subband is provided, and the signal to noise power ratio SNR needed to achieve the specific variance requirement of the MLE is derived. Next, using the Doppler transformation, we show how to combine the output response of each subband undergoing a different Doppler shift. Finally, the CAF approximation of all the targets is attained, having the improved delay-Doppler resolution and thus providing a way to resolve initially undetected targets using a recursive procedure. First, general CRB expressions are derived for a narrowband signal and array model and a space-time separable noise model First, general CRB expressions are derived for a narrowband signal and array model and a space-time separable noise model that allows both spa-tial and temporal correlation. We discuss the relationship between the CRB and ambiguity function for this model. Then, we spe-cialize our CRB results to the case of temporally white noise and the practically important signal shape of a linear frequency modulated chirp pulse sequence. For this measure, we show that the highest and lowest target location accuracy is achieved if the target lies along one of the principal axes of inertia of the array. Finally, we compare the location accuracies of several array geometries. Show Context Citation Context Continuous-time results are often easier to interpret, at the cost of neglecting finite sampling effects. They also allow for timeâ€"frequency interpretations of the CRB. Zoubir, Boualem Boashash, Branko Ristic "

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Physical fundamentals of the radar principle transmitted energy Figure 1: The measuring of a round trip time of a microwave pulse transmitted energy Figure 1: The measuring of a round trip time of a microwave pulse What is Radar? Physical fundamentals of the radar principle The basic principle of operation of primary radar is simple to understand. However, the theory can be quite complex. An understanding of the theory is essential in order to be able to specify and operate primary radar systems correctly. The implementation and operation of primary radars systems involve a wide range of disciplines such as building works, heavy mechanical and electrical engineering, high power microwave engineering, and advanced high speed signal and data processing techniques. Some laws of nature have a greater importance here. Radar measurement of range, or distance, is made possible because of the properties of radiated electromagnetic energy. Reflection of electromagnetic waves The electromagnetic waves are reflected if they meet an electrically leading surface. If these reflected waves are received again at the place of their origin, then that means an obstacle is in the propagation direction. Electromagnetic energy travels through air at a constant speed, at approximately the speed of light, , kilometers per second or , statute miles per second or , nautical miles per second. This constant speed allows the determination of the distance between the reflecting objects airplanes, ships or cars and the radar site by measuring the running time of the transmitted pulses. This energy normally travels through space in a straight line, and will vary only slightly because of atmospheric and weather conditions. By using of special radar antennas this energy can be focused into a desired direction. Thus the direction in azimuth and elevation of the reflecting objects can be measured. These principles can basically be implemented in a radar system, and allow the determination of the distance, the direction and the height of the reflecting object. The effects atmosphere and weather have on the transmitted energy will be discussed later; however, for this discussion on determining range and direction, these effects will be temporarily ignored. Advantages Radar has many advantages compared to an attempt of visual observation: Radar is able to operate day or night, in lightness or darkness over a long range; Radar is able to operate in all weathers, in fog and rain, it can even penetrate walls or layers of snow; Radar has very broad coverage; it is possible to observe the whole hemisphere; Radar detects and tracks moving objects, a high resolution imaging is possible, that results in an object recognition; Radar can operate unmanned, 24 hours a day, 7 days a week. Christian Wolff Revised by Karina Hoel.

Chapter 5 : Principles of High-resolution Radar : August W. Rihaczek :

The development of radar resolution theory is examined in this text. Key topics include the capabilities and limits of radar, the details of radar design, fundamentals of waveform analysis, pulse compression waveforms, coherent pulse trains and detection c.

Chapter 6 : Radar Basics - Range Resolution

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This re-lease of the classic text examines step-by-step the development of radar resolution theory. Key topics include the capabilities and limits of radar and the details of radar design.

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