Detecting And Classifying Low Probability Of Intercept Radar

This book reviews the major progress made in the fields of atomic, molecular and optical physics in the last decade. It contains eleven chapters in which contributors have highlighted the major accomplishments made in a given subfield. Each chapter is not a comprehensive review, but rather a succinct survey of the most interesting developments achieved in recent years. This book contains information on many AMO subfields and can be used as a textbook for graduate students interested in entering AMO physics. It may also serve researchers who wish to familiarize themselves with other AMO subfields.

The characteristic of low probability of intercept (LPI) radar makes it difficult to intercept with conventional signal intelligence methods so new interception methods need to be developed. This thesis initially describes a simulation of a polytime phase-coded LPI signal. The thesis then introduces a method for classification of LPI radar signals. The method utilizes a parallel tree structure with three separate 'branches' to exploit the image representation formed by three separate detection methods. Each detection method output is pre-processed and features are extracted using image processing. After processing the images, they are each fed into three separate neural networks to be classified. The classification output of each neural network is then combined and fed into a fourth neural network performing the final classification. The outcome of testing shows only 53%, which might be the result of the image representation of the detection methods not being distinct enough, the pre - processing/feature extraction not being able to extract relevant information or the neural networks not being properly trained. The thesis concludes with a brief discussion about a suitable method for image processing to extract significant parameters from a LPI signal.

Radar Expert, Esteemed Author Gregory L. Charvat on CNN and CBSAuthor Gregory L. Charvat appeared on CNN on March 17, 2014 to discuss whether Malaysia Airlines Flight 370 might have literally flown below the radar. He appeared again on CNN on March 20, 2014 to explain the basics of radar, and he explored the hope and limitations of the technology i

Written by a prominent expert in the field, this updated and expanded second edition of an Artech House classic includes the most recent breakthroughs in vital sign and gender recognition via micro-radar, as well as covering basic principles of Doppler effect and micro-Doppler effect and describing basic applications of micro-Doppler signatures in radar. The book presents detailed procedures about how to generate and analyze micro-Doppler signatures from radar signals. Readers will learn how to model and animate an object (such as human, spinning top, rotating rotor blades) with movement, simulation of radar returns from the object, and generating micro-Doppler signature. The book includes coverage of the Google project "Soli", which demonstrated the use of radar micro-Doppler effect to sense and recognize micro motions of human hand gesture for controlling devices. It also discusses noncontact detection of human vital sign (micro motions of breathing and heart beating) using radar, another important application of radar micro-Doppler sensors. Detailed MATLAB source codes for simulation of radar backscattering from targets with various motions are provided, along with source codes for generating micro-Doppler signatures and

analyzing characteristics of targets.

This thesis documents the use of the SRC-6 Reconfigurable Computer for use in analyzing low probability of intercept (LPI) signals using the Choi-Williams distribution. The SRC-6 is a reconfigurable computer manufactured by SRC Computers, Inc. which allows the user to tailor both the software and the hardware to a specific task. This increases the speed at which the task can be accomplished making it useful for applications in electronic intelligence (ELINT). The Choi-Williams distribution is a mathematical technique that was first created using MATLAB and then converted to C code for use on the SRC-6. The purpose of this study is to investigate the feasibility of using a reconfigurable computer for ELINT applications and the timely detection and classification of LPI signals. This thesis is part of a larger study to use reconfigurable computers for the autonomous detection and classification of LPI signals.

Serving as a continuation of the bestselling book EW 101: A First Course in Electronic Warfare, this new volume is a second book based on the popular tutorials featured in the Journal of Electronic Defense. Without delving into complex mathematics, this book lets you understand important concepts central to EW, so you gain a basic working knowledge of the technologies and techniques deployed in today's EW systems.

All papers including in this proceedings had undergone the strict peer-review by the experts before they are accepted for publications. This proceeding covers the subjects of analog circuits and digital circuits, assembly and packaging, biomedical circuits, computer architecture, computer engineering, control engineering, electric power system and automation, energy and power systems, instrumentation engineering, signal processing and other related areas. We hope this proceeding will contribute in stimulating debate and research among scholars, researchers and academicians.

CEEE 2014 is to provide a forum for researchers, academicians, engineers, and government officials from all over the world to involved in the general areas of Electronics and Electrical Engineering to disseminate their latest research results and exchange views on the future research directions of these fields.This conference provides opportunities for the participants to exchange new ideas and application experiences face to face.

This book describes the essential tools and techniques of statistical signal processing. At every stage theoretical ideas are linked to specific applications in communications and signal processing using a range of carefully chosen examples. The book begins with a development of basic probability, random objects, expectation, and second order moment theory followed by a wide variety of examples of the most popular random process models and their basic uses and properties. Specific applications to the analysis of random signals and systems for communicating, estimating, detecting, modulating, and other processing of signals are interspersed throughout the book. Hundreds of homework problems are included and the book is ideal for graduate students of electrical engineering and applied mathematics. It is also a useful reference for researchers in signal processing and communications.

This book is a printed edition of the Special Issue "UAV-Based Remote Sensing" that was published in Sensors

The third book in the bestselling Artech House EW 100 series is dedicated entirely to the practical aspects of electronic warfare against enemy communication. From communications math (mainly simple dB formulas), receiving systems, and signals, to

communications emitter location, interecept, and jamming, this comprehensive volume covers all the key topics in the field.

This book, divided in two volumes, originates from Techno-Societal 2020: the 3rd International Conference on Advanced Technologies for Societal Applications, Maharashtra, India, that brings together faculty members of various engineering colleges to solve Indian regional relevant problems under the guidance of eminent researchers from various reputed organizations. The focus of this volume is on technologies that help develop and improve society, in particular on issues such as sensor and ICT based technologies for the betterment of people, Technologies for agriculture and healthcare, micro and nano technological applications. This conference aims to help innovators to share their best practices or products developed to solve specific local problems which in turn may help the other researchers to take inspiration to solve problems in their region. On the other hand, technologies proposed by expert researchers may find applications in different regions. This offers a multidisciplinary platform for researchers from a broad range of disciplines of Science, Engineering and Technology for reporting innovations at different levels.

Automatic Modulation Classification (AMC) has been a key technology in many military, security, and civilian telecommunication applications for decades. In military and security applications, modulation often serves as another level of encryption; in modern civilian applications, multiple modulation types can be employed by a signal transmitter to control the data rate and link reliability. This book offers comprehensive documentation of AMC models, algorithms and implementations for successful modulation recognition. It provides an invaluable theoretical and numerical comparison of AMC algorithms, as well as guidance on state-of-the-art classification designs with specific military and civilian applications in mind. Key Features: Provides an important collection of AMC algorithms in five major categories, from likelihood-based classifiers and distribution-test-based classifiers to feature-based classifiers, machine learning assisted classifiers and blind modulation classifiers Lists detailed implementation for each algorithm based on a unified theoretical background and a comprehensive theoretical and numerical performance comparison Gives clear guidance for the design of specific automatic modulation classifiers for different practical applications in both civilian and military communication systems Includes a MATLAB toolbox on a companion website offering the implementation of a selection of methods discussed in the book

Learn how to apply test-driven development (TDD) to machine-learning algorithms—and catch mistakes that could sink your analysis. In this practical guide, author Matthew Kirk takes you through the principles of TDD and machine learning, and shows you how to apply TDD to several machine-learning algorithms, including Naive Bayesian classifiers and Neural Networks. Machine-learning algorithms often have tests baked in, but they can't account for human errors in coding. Rather than blindly rely on machine-learning results as many researchers have, you can mitigate the risk of errors with TDD and write clean, stable machine-learning code. If you're familiar with Ruby 2.1, you're ready to start. Apply TDD to write and run tests before you start coding Learn the best uses and tradeoffs of eight machine learning algorithms Use real-world examples to test each algorithm through engaging, hands-on exercises Understand the similarities between TDD and the scientific method for validating solutions Be aware of the risks of

machine learning, such as underfitting and overfitting data Explore techniques for improving your machine-learning models or data extraction

This book provides a novel method for topic detection and classification in social networks. The book addresses several research and technical challenges that are currently being investigated by the research community, from the analysis of relations and communications between members of a community, to quality, authority, relevance and timeliness of the content, traffic prediction based on media consumption, spam detection, to security, privacy and protection of personal information. Furthermore, the book discusses innovative techniques to address those challenges and provides novel solutions based on information theory, sequence analysis and combinatorics, which are applied on real data obtained from Twitter.

A thorough update to the Artech House classic Modern Radar Systems Analysis, this reference is a comprehensive and cohesive introduction to radar systems design and performance estimation. It offers you the knowledge you need to specify, evaluate, or apply radar technology in civilian or military systems. The book presents accurate detection range equations that let you realistically estimate radar performance in a variety of practical situations. With its clear, easy-to-understand language, you quickly learn the tradeoffs between choice of wavelength and radar performance and see the inherent advantages and limitations associated with each radar band. You find modeling procedures to help you analyze enemy systems or evaluate radar integrated into new weapon systems. The book covers ECM and ECCM for both surveillance and tracking to help you estimate the effects of active and passive ECM, select hardware/software for reconnaissance or jamming, and plan the operation of EW systems. As radar systems evolve, this book provides the equations needed to calculate and evaluate the performance of the latest advances in radar technology.

"The world's most authoritative resource on LPI emitter design and counter-LPI techniques is now updated with the latest developments in the field, complete with 360 task-clarifying illustrations and ready-to-use MATLAB simulations for every LPI modulation in the book. This revised and expanded second edition brings you to the cutting edge with new chapters on LPI radar design, including over-the-horizon radar, random noise radar, and netted LPI radar. You also discover critical LPI detection techniques, parameter extraction signal processing techniques, and anti-radiation missile design strategies to counter LPI radar.

This highly-anticipated second edition of the bestselling Cognitive Radar: The Knowledge-Aided Fully Adaptive Approach, the first book on the subject, provides up-to-the-minute advances in the field of cognitive radar (CR). Adaptive waveform methods are discussed in detail, along with optimum resource allocation and radar scheduling. Chronicling the field of cognitive radar (CR), this cutting-edge resource provides an accessible introduction to the theory and applications of CR, and presents a comprehensive overview of the latest developments in this emerging area. It covers important breakthroughs in advanced radar systems, and offers new and powerful methods for combating difficult clutter environments. You find details on specific algorithmic and real-time high-performance embedded computing (HPEC) architectures. This practical book is supported with numerous examples that clarify key topics, and includes more than 370 equations.

Monopulse is a type of radar that sends additional information in the signal in order to avoid problems caused by rapid changes in signal strength. Monopulse is resistant to jamming which is one of the main reasons it is used in most radar systems today. This updated and expanded

edition of an Artech House classic offers you a current and comprehensive treatment of monopulse radar principles, techniques, and applications. The Second Edition features two brand new chapters, covering monopulse countermeasures and counter-countermeasures and monopulse for airborne radar and homing seekers. This essential volume categorizes and describes the various forms of monopulse radar, and analyzes their capabilities and limitations. The book also devotes considerable space to monopulse circuits and hardware components, explaining their functions and performance. This practical resource features numerous photographs and illustrations drawn from actual radar systems and components. This book serves as a valuable reference for both experienced radar engineers and those new to the field.

An excellent resource for engineers and technicians alike, this practical design guide offers a comprehensive and easy-to-understand overview of the most important aspects and components of radio frequency equipment and systems. The book applies theoretical fundamentals to real-world issues, heavily relying on examples from recent design projects. Key discussions include system design schemes, circuits and components for system evaluations and design, RF measurement instrumentation, antennas and associated hardware, and guidelines for purchasing test equipment. The book also serves as a valuable on-the-job training resources for sales engineers and a graduate-level text for courses in this area. Discover the technology for the next generation of radar systems Here is the first book that brings together the key concepts essential for the application of Knowledge Based Systems (KBS) to radar detection, tracking, classification, and scheduling. The book highlights the latest advances in both KBS and radar signal and data processing, presenting a range of perspectives and innovative results that have set the stage for the next generation of adaptive radar systems. The book begins with a chapter introducing the concept of Knowledge Based (KB) radar. The remaining nine chapters focus on current developments and recent applications of KB concepts to specific radar functions. Among the key topics explored are: Fundamentals of relevant KB techniques KB solutions as they apply to the general radar problem KBS applications for the constant false-alarm rate processor KB control for space-time adaptive processing KB techniques applied to existing radar systems Integrated end-to-end radar signals Data processing with overarching KB control All chapters are self-contained, enabling readers to focus on those topics of greatest interest. Each one begins with introductory remarks, moves on to detailed discussions and analysis, and ends with a list of references. Throughout the presentation, the authors offer examples of how KBS works and how it can dramatically improve radar performance and capability. Moreover, the authors forecast the impact of KB technology on future systems, including important civilian, military, and homeland defense applications. With chapters contributed by leading international researchers and pioneers in the field, this text is recommended for both students and professionals in radar and sonar detection, tracking, and classification and radar resource management.

Effective risk management is essential for the success of large projects built and operated by the Department of Energy (DOE), particularly for the one-of-a-kind projects that characterize much of its mission. To enhance DOE's risk management efforts, the department asked the NRC to prepare a summary of the most effective practices used by leading owner organizations. The study's primary objective was to provide DOE project managers with a basic understanding of both the project owner's risk management role and effective oversight of those risk management activities delegated to contractors.

Low probability of intercept (LPI) is that property of an emitter that because of its low power, wide bandwidth, frequency variability, or other design attributes, makes it difficult to be detected or identified by means of passive intercept devices such as radar warning, electronic support and electronic intelligence receivers, In order to detect LPI radar waveforms new

signal processing techniques are required This thesis first develops a MATLAB toolbox to generate important types of LPI waveforms based on frequency and phase modulation The power spectral density and the periodic ambiguity function are examined for each waveforms These signals are then used to test a novel signal processing technique that detects the waveforms parameters and classifies the intercepted signal in various degrees of noise, The technique is based on the use of parallel filter (sub-band) arrays and higher order statistics (third- order cumulant estimator) Each sub-band signal is treated individually and is followed by the third-order estimator in order to suppress any symmetrical noise that might be present, The significance of this technique is that it separates the LPI waveforms in small frequency bands, providing a detailed time-frequency description of the unknown signal, Finally, the resulting output matrix is processed by a feature extraction routine to detect the waveforms parameters Identification of the signal is based on the modulation parameters detected,

Explores the application of statistical signal processing to hyperspectral imaging and further develops non-literal (spectral) techniques for subpixel detection and mixed pixel classification. This text is the first of its kind on the topic anc can be considered a recipe book offering various techniques for hyperspectral data exploitation.

This book deals with the basic theory for design and analysis of Low Probability of Intercept (LPI) radar systems. The design of one such multi-frequency high resolution LPI radar, PANDORA, is covered. This work represents the first time that the topic of multi-frequency radars is discussed in such detail and it is based on research conducted by the author in The Netherlands. The book provides the design tools needed for development, design, and analysis of high resolution radar systems for commercial as well as military applications. Software written in MATLAB and C++ is provided to guide the reader in calculating radar parameters and in ambiguity function analysis. Some radar simulation software is also included.

This proceedings set contains selected Computer, Information and Education Technology related papers from the 2014 International Conference on Computer, Intelligent Computing and Education Technology (CICET 2014), held March 27-28, 2014 in Hong Kong. The proceedings aims to provide a platform for researchers, engineers and academics as well as industry professionals from all over the world to present their research results and development activities in Computer Science, Information Technology and Education Technology.

This comprehensive resource provides theoretical formulation for detecting and geolocating non-cooperative emitters. Implementation of geolocation algorithms are discussed, as well as performance prediction of a hypothetical passive location system for systems analysis or vulnerability calculation. Comparison of novel direction finding and geolocation algorithms to classical forms are also included. Rooted in statistical signal processing and array processing theory, this book also provides an overview of the application of novel detection and estimation algorithms to real world problems in EW. The book is divided into three parts: detection, angle of arrival estimation, and geolocation. Each section begins with an introductory chapter covering the relevant signal processing theory (either detection or estimation), then provides a series of chapters covering specific methods to achieve the desired end-product. MATLAB® code is provided to assist readers with relevant probability and statistics, RF propagation, atmospheric absorption, and noise, giving readers an understanding of the implementation of the algorithms in the book, as well as developing new approaches to solving problems. Packed with problem sets and examples, this book strikes a balance between introductory texts and reference manuals, making it useful for novice as well

as advanced practitioners.

Non-Line-of-Sight Radar is the first book on the new and exciting area of detecting and tracking targets via radar multipath without direct-line-of-sight (DLOS). This revolutionary capability is finding new applications in the tracking of objects in non-line-of-sight (NLOS) urban environments including detection and tracking of UAVs. This book brings together for the first time all the essential underpinnings and techniques required to develop and field a viable NLOS radar. It presents many examples, including electromagnetic radiation propagation in urban NLOS environments, extracting building location and morphology from readily available terrain databases, predictive ray-tracing techniques, and multi-target NLOS tracking. Readers will learn how to apply radar to urban tracking that was previously deemed impossible. The book shows how real-time physics calculations can be incorporated into the radar processor, and how existing radar hardware can be adopted for non-line-of-sight radar use without major upgrades. Including results from both high-fidelity, physics-based simulations and actual flight test data, this book establishes the efficacy of NLOS radar in practical applications.

This revised and expanded second edition brings you to the cutting edge with new chapters on LPI radar design, including over-the-horizon radar, random noise radar, and netted LPI radar. You also discover critical LPI detection techniques, parameter extraction signal processing techniques, and anti-radiation missile design strategies to counter LPI radar.

This book is a printed edition of the Special Issue "Symmetry Measures on Complex Networks" that was published in Symmetry

Compiled by leading authorities, Aerospace Navigation Systems is a compendium of chapters that present modern aircraft and spacecraft navigation methods based on up-to-date inertial, satellite, map matching and other guidance techniques. Ranging from the practical to the theoretical, this book covers navigational applications over a wide range of aerospace vehicles including aircraft, spacecraft and drones, both remotely controlled and operating as autonomous vehicles. It provides a comprehensive background of fundamental theory, the utilisation of newly-developed techniques, incorporates the most complex and advanced types of technical innovation currently available and presents a vision for future developments. Satellite Navigation Systems (SNS), long range navigation systems, short range navigation systems and navigational displays are introduced, and many other detailed topics include Radio Navigation Systems (RNS), Inertial Navigation Systems (INS), Homing Systems, Map Matching and other correlated-extremalsystems, and both optimal and sub-optimal filtering in integrated navigation systems.

In answer to great demand, Artech House is proud to bring professionals a newly revised and updated edition of the bestselling book Introduction to Modern EW Systems. The Second Edition has been greatly expanded to include a wealth of new material, from remote piloted airborne systems, directed energy weapons, and non-cooperative air surveillance...to EW radar band sensor next generation architectures, real-time data links, and smart jamming. This authoritative resource provides engineers and students with the latest electronic warfare (EW) techniques and technologies related to on-board military platforms. Practitioners gain expert design guidance on technologies and equipment used to detect and identify emitter threats, offering an

advantage in the never-ending chess game between sensor guided weapons and EW systems. This unique book provides deeper insight into EW systems principles of operation and their mathematical descriptions, arming professionals with better knowledge for their specific design applications. Moreover, readers get practical information on how to counter modern communications data links which provide connectivity and command flow among the armed forces in the battlefield. Taking a sufficiently broad perspective, this comprehensive volume offers a panoramic view of the various physical domains RF, Infrared, and electronics that are present in modern electronic warfare systems. This in-depth book is supported with over 340 illustrations and more than 450 equations.

This highly practical resource provides you with thorough working knowledge of the micro-Doppler effect in radar, including its principles, applications and implementation with MATLAB codes. The book presents code for simulating radar backscattering from targets with various motions, generating micro-Doppler signatures, and analyzing the characteristics of targets. You find detailed descriptions of the physics and mathematics of the Doppler and micro-Doppler effect. Moreover, you learn how to derive rigid and non-rigid body motion induced micro-Doppler effect in radar scattering. The book provides a wide range of clear examples, including an oscillating pendulum, a spinning and precession heavy top, rotating rotor blades of a helicopter, rotating wind-turbine blades, a person walking with swinging arms and legs, a flying bird, and movements of quadruped animals.

Offering engineers a thorough examination of special, more advanced aspects of digital wideband receiver design, this practical book builds on fundamental resources on the topic, helping you gain a more comprehensive understanding of the subject. This in-depth volume presents a detailed look at a complete receiver design, including the encoder. Moreover, it discusses the detection of exotic signals and provides authoritative guidance on designing receivers used in electronic warfare. From frequency modulation and biphase shifting keys, to parameter encoders in electronic warfare receivers and the use of the simulation and probability density function to predict the false alarm parameter, this book focuses on critical topics and techniques that help you design digital wideband receivers for top performance. The authoritative reference is supported with over 310 illustrations and more than 180 equations.

Laser-Based Optical Detection of Explosives offers a comprehensive review of past, present, and emerging laser-based methods for the detection of a variety of explosives. This book: Considers laser propagation safety and explains standard test material preparation for standoff optical-based detection system evaluation Explores explosives detection using deep ultraviolet native fluorescence, Raman spectroscopy, laser-induced breakdown spectroscopy, reflectometry, and hyperspectral imaging Examines photodissociation followed by laser-induced fluorescence, photothermal methods, cavity-enhanced absorption spectrometry, and short-pulse laser-based techniques Describes the detection and recognition of explosives using terahertz-frequency spectroscopic techniques Each chapter is authored by a leading expert on the respective technology, and is structured to supply historical perspective, address current advantages and challenges, and discuss novel research and applications. Readers are left with an in-depth understanding and appreciation of each technology's capabilities and potential for standoff hazard detection.

These proceedings of the symposium ISIT 2014 aim to be a platform for international exchange of the state-of-the-art research and practice in information technology. The contributions cover a wide variety of topics, ranging from theoretical and analytical studies to various applications.

Frequency Modulated Continuous Wave (FMCW) radars are a fast expanding area in radar technology due to their stealth features, extremely high resolutions, and relatively clutter free displays. This groundbreaking resource offers engineers expert guidance in designing narrowband FMCW radars for surveillance, navigation, and missile seeking. It also provides professionals with a thorough understanding of underpinnings of this burgeoning technology. Moreover, readers find detailed coverage of the RF components that form the basis of radar construction. Featuring clear examples, the book presents critical discussions on key applications. Practitioners learn how to use time-saving MATLAB® and SystemVue design software to help them with their challenging projects in the field. Additionally, this authoritative reference shows engineers how to analyze FMCW radars of various types, including missile seekers and missile altimeters. Packed with over 600 equations, the book presents discussions on key radar algorithms and their implementation, as well as designing modern radar to meet given operational requirements.

Written by a prominent expert in the field, this authoritative new resource presents anti-ship missile (ASM) electronic protection (EP) techniques designed to enhance accurate target classification currently being developed by personnel from the People's Republic of China and other nations. This book provides a comprehensive introduction to modern electronic warfare (EW) in an era of information warfare (IW). It explores the capabilities of coherent radar and digital signal processing to rapidly and accurately classify targets. Both naval and air electronic EW are covered in this resource. This book gives insight into modern EW as an information battle and includes guidance on properly testing the effectiveness of electronic attack (EA) systems. Pulsed Doppler radar basics including, electromagnetic pulse, dynamic range, gain control, and Doppler effects are presented. A summary of the ASM sensor and EA model is provided and readers find coverage of the radar range equation, burn through, and the range Doppler map and imaging. Special topic-extended target classifications including, false, decoys, and chaff are explained. Special topic ASM EP waveforms and multiple receiver EP are also covered. This book explores features of algorithms to optimize combining multiple parameters and systems. Moreover, it explains several algorithms proposed by PRC personnel to implement optimal two-channel processing that mitigates cover noise EA.