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Synthetic aperture radar (SAR) is a well-known remote sensing technique, but conventional single-antenna SAR is inherently limited by the minimum antenna area constraint. Although there are still technical issues to overcome, multi-antenna SAR offers many benefits, from improved system gain to increased degrees-of-freedom and system flexibility. Multi-Antenna Synthetic Aperture Radar explores the potential and challenges of using multi-antenna SAR in microwave remote sensing applications. These applications include high-resolution imaging, wide-swath remote sensing, ground moving target indication, and 3-D imaging. The book pays particular attention to the signal processing aspects of various multi-antenna SAR from a top-level system perspective. Explore Recent Extensions of Synthetic Aperture Radar Systems The backbone of the book is a series of innovative microwave remote sensing approaches developed by the author. Centered around multi-antenna SAR imaging, these approaches address specific challenges and potential problems in future microwave remote sensing. Chapters examine single-input multiple-output (SIMO) multi-antenna SAR, including azimuth and elevation multi-antenna SAR, and multiple-input multiple-output (MIMO) SAR. The book details the corresponding system scheme, signal models, time/phase/spatial synchronization methods, and high-precision imaging algorithms. It also investigates their potential applications. Introductory Tutorials and Novel Approaches in Multi-Antenna SAR Imaging Rigorous and self-contained, this is a unique reference for researchers and industry professionals working with microwave remote sensing, SAR imaging, and radar signal processing. In addition to novel approaches, the book also presents tutorials that serve as an introduction to multi-antenna SAR imaging for those who are new to the field.

This unique resource presents the principles of meter wave ground imaging radar focusing on foliage penetration. Scattering of VHF/UHF radar signals are presented including the basic laws of electromagnetism, homogeneous media, media discontinuities/non-flat media discontinuities, and ground reflectivity. The book introduces meter wavelength synthetic aperture radar, bandwidth, and SAR imaging principles, including moving objects and also compares collected SAR data. Meter wavelength SAR system design and processing is explored, highlighting low frequency SAR design aspects, characterization of additive noise, antenna system basics, waveforms and emission adaptation which is critical material to the advancement in sensors and signal processing for below ground imaging by the energy industry and governments worldwide.

Principles of Synthetic Aperture Radar Imaging: A System Simulation Approach demonstrates the use of image simulation for SAR. It covers the various applications of SAR (including feature extraction, target classification, and change detection), provides a complete understanding of SAR principles, and illustrates the complete chain of a SAR operation. The book places special emphasis on a ground-based SAR, but also explains space and air-borne systems. It contains chapters on signal speckle, radar-signal models, sensor-trajectory models, SAR-image focusing, platform-motion compensation, and microwave-scattering from random media. While discussing SAR image focusing and motion compensation, it presents processing algorithms and applications that feature extraction, target classification, and change detection. It also provides samples of simulation on various scenarios, and includes simulation flowcharts and results that are detailed throughout the book. Introducing SAR imaging from a systems point of view, the author: Considers the recent development of MIMO SAR technology Includes selected GPU implementation Provides a numerical analysis of system parameters (including platforms, sensor, and image focusing, and their influence) Explores wave-target interactions, signal transmission and reception, image formation, motion compensation Covers all platform motion compensation and error analysis, and their impact on final image radiometric and geometric quality Describes a ground-based SFMCW system Principles of Synthetic Aperture Radar Imaging: A System Simulation Approach is dedicated to the use, study, and development of SAR systems. The book focuses on image formation or focusing, treats platform motion and image focusing, and is suitable for students, radar engineers, and microwave remote sensing researchers.

Synthetic Aperture Radar (SAR) is critical for remote sensing. It works day and night, in good weather or bad. Bistatic SAR is a new kind of SAR system, where the transmitter and receiver are placed on two separate platforms. Bistatic SAR is one of the most important trends in SAR development, as the technology renders SAR more flexible and safer when used in military environments. Imaging is one of the most difficult and important aspects of bistatic SAR data processing. Although traditional SAR signal processing is fully developed, bistatic SAR has a more complex system structure, so signal processing is more challenging. Focusing on imaging aspects of bistatic SAR signal processing, this book covers resolution analysis, echo generation methods, imaging algorithms, imaging parameter estimation, and motion compensation methods. The book is ideal for researchers and engineers in SAR signal and data processing, as well as those working in bistatic and multistatic radar imaging, and in the radar sciences. Graduate students with a background in radar who are interested in bistatic and multistatic radar will find this book a helpful reference. Gives a general and updated framework for image formation using signal processing aspects Starts with an introduction to traditional SAR before moving onto more advanced topics Offers readers a range of exhaustive tools to process signals and

form images Provides a solid reference for the imaging of other complicatedSAR Sample image synthesis exercises are available from the book'scompanion site

Synthetic aperture radar provides broad-area imaging at highresolutions, which is used in applications such as environmentalmonitoring, earth-resource mapping, and military systems. This book presents the tools required for the digital processing ofsynthetic aperture radar images. They are of three types: (a) theelements of physics, (b) mathematical models and (c) imageprocessing methods adapted to particular applications.

The past forty years have seen a number of imaging modalities developed for radar, sonar, diagnostic medicine, geophysical and celestial exploration, and non-destructive testing. Now, for those involved in designing and developing information processing tools for these imaging systems, author Mehrdad Soumekh offers in-depth coverage of diverse issues such as physical and mathematical modeling of the problem, signal processing, reconstruction, analysis of resolution and system parameter constraints, hardware structure used for data acquisition, and the overall imaging system block diagram (signal flow-chart) indicating how the acquired data are processed to yield the final reconstructed image. Fourier Array Imaging introduces the spatial Doppler phenomenon in conjunction with the most primitive signal processing tools and systems used in array imaging; presents terminologies and tools for two-dimensional signal processing; treats specific array imaging systems via the unifying framework of spatial Doppler processing, including phased-array imaging, synthetic aperture array (SAR and ISAR) imaging, passive array imaging, and bistatic array imaging with emphasis on transmission imaging problems of diagnostic medicine and geophysical exploration; devotes coverage to the analysis of resolution anticipated in an imaging system and to the constraints that are instrumental for selecting parameters of an imaging system; describes some of the classical methods used for image formation in array imaging systems and relates them to the spatial Doppler-based imaging via certain approximations.

This book provides a full representation of Inverse Synthetic Aperture Radar (ISAR) imagery, which is a popular and important radar signal processing tool. The book covers all possible aspects of ISAR imaging. The book offers a fair amount of signal processing techniques and radar basics before introducing the inverse problem of ISAR and the forward problem of Synthetic Aperture Radar (SAR). Important concepts of SAR such as resolution, pulse compression and image formation are given together with associated MATLAB codes. After providing the fundamentals for ISAR imaging, the book gives the detailed imaging procedures for ISAR imaging with associated MATLAB functions and codes. To enhance the image quality in ISAR imaging, several imaging tricks and fine-tuning procedures such as zero-padding and windowing are also presented. Finally, various real applications of ISAR imagery, like imaging the antenna-platform scattering, are given in a separate chapter. For all these algorithms, MATLAB codes and figures are included. The final chapter considers advanced concepts and trends in ISAR imaging.

Modern airborne and spaceborne imaging radars, known as synthetic aperture radars (SARs), are capable of producing high-quality pictures of the earth's surface while avoiding some of the shortcomings of certain other forms of remote imaging systems. Primarily, radar overcomes the nighttime limitations of optical cameras, and the cloud- cover limitations of both optical and infrared imagers. In addition, because imaging radars use a form of coherent illumination, they can be used in certain special modes such as interferometry, to produce some unique derivative image products that incoherent systems cannot. One such product is a highly accurate digital terrain elevation map (DTEM). The most recent (ca. 1980) version of imaging radar, known as spotlight-mode SAR, can produce imagery with spatial resolution that begins to approach that of remote optical imagers. For all of these reasons, synthetic aperture radar imaging is rapidly becoming a key technology in the world of modern remote sensing. Much of the basic `workings' of synthetic aperture radars is rooted in the concepts of signal processing. Starting with that premise, this book explores in depth the fundamental principles upon which the spotlight mode of SAR imaging is constructed, using almost exclusively the language, concepts, and major building blocks of signal processing. Spotlight-Mode Synthetic Aperture Radar: A Signal Processing Approach is intended for a variety of audiences. Engineers and scientists working in the field of remote sensing but who do not have experience with SAR imaging will find an easy entrance into what can seem at times a very complicated subject. Experienced radar engineers will find that the book describes several modern areas of SAR processing that they might not have explored previously, e.g. interferometric SAR for change detection and terrain elevation mapping, or modern non-parametric approaches to SAR autofocus. Senior undergraduates (primarily in electrical engineering) who have had courses in digital signal and image processing, but who have had no exposure to SAR could find the book useful in a one-semester course as a reference.

This book is devoted to the emerging technology of noise waveform radar and its signal processing aspects. It is a new kind of radar, which use noise-like waveform to illuminate the target. The book includes an introduction to basic radar theory, starting from classical pulse radar, signal compression, and wave radar. The book then discusses the properties, difficulties and potential of noise radar systems, primarily for low-power and short-range civil applications. The contribution of modern signal processing techniques to making noise radar practical are emphasized, and application examples are given.

Explore the principles and applications of synthetic aperture radar This comprehensive guide offers a solid grounding in synthetic aperture radar (SAR) fundamentals and techniques. Written by a remote sensing and signal processing expert, Introduction to Synthetic Aperture Radar: Concepts and Practice clearly explains data collection, image formation, error correction, and image quality. You will get concise descriptions of commonly used image formation algorithms, including the Range-Doppler Algorithm (RDA) and the Polar Formatting Algorithm (PFA). Continuous wave LFM systems, interferometry, polarimetry, and moving objects are discussed in detail. Coverage includes: Origins of synthetic aperture radar Ranging and imaging Image formation and image processing tools Linear frequency-modulated chirp Image formation algorithms for quadrature demodulated data Image formation algorithms for dechirped data Autofocus Image quality and speckle reduction Linear frequency-modulated continuous wave systems Remote sensing Interferometry Moving objects in SAR

Build your knowledge of SAR/ISAR imaging with this comprehensive and insightful resource The newly revised Second Edition of Inverse Synthetic Aperture Radar Imaging with MATLAB Algorithms covers in greater detail the fundamental and advanced topics necessary for a complete understanding of inverse synthetic aperture radar (ISAR) imaging and its concepts. Distinguished author and academician, Caner Özdemir, describes the practical aspects of ISAR imaging and presents illustrative

examples of the radar signal processing algorithms used for ISAR imaging. The topics in each chapter are supplemented with MATLAB codes to assist readers in better understanding each of the principles discussed within the book. This new edition incudes discussions of the most up-to-date topics to arise in the field of ISAR imaging and ISAR hardware design. The book provides a comprehensive analysis of advanced techniques like Fourier-based radar imaging algorithms, and motion compensation techniques along with radar fundamentals for readers new to the subject. The author covers a wide variety of topics, including: Radar fundamentals, including concepts like radar cross section, maximum detectable range, frequency modulated continuous wave, and doppler frequency and pulsed radar The theoretical and practical aspects of signal processing algorithms used in ISAR imaging The numeric implementation of all necessary algorithms in MATLAB ISAR hardware, emerging topics on SAR/ISAR focusing algorithms such as bistatic ISAR imaging, polarimetric ISAR imaging, and near-field ISAR imaging, Applications of SAR/ISAR imaging techniques to other radar imaging problems such as thru-the-wall radar imaging and ground-penetrating radar imaging Perfect for graduate students in the fields of electrical and electronics engineering, electromagnetism, imaging radar, and physics, Inverse Synthetic Aperture Radar Imaging With MATLAB Algorithms also belongs on the bookshelves of practicing researchers in the related areas looking for a useful resource to assist them in their day-to-day professional work.

This practical reference shows SAR system designers and remote sensing specialists how to produce higher quality SAR images using data-driven algorithms, and apply powerful new techniques to measure and analyze SAR image content.

This comprehensive introduction to synthetic aperture radar (SAR) is a practical guide to the analysis, simulation, and design of SAR systems. The video eBook uses constructive examples and real--world collected datasets to demonstrate image registration and autofocus methods. Both two- and three-dimensional image formation algorithms are presented. Hardware, software, and environmental parameters are used to estimate performance limits for SAR operation and utilization. A set of Python and MATLAB software tools is included and provides you with an effective mechanism to analyze and predict SAR performance for various imaging scenarios and applications. Examples which use the software tools are provided at the end of each chapter to reinforce critical SAR imaging topics such as clutter-to-noise ratio, mapping rate, spatial resolution, Doppler bandwidth, pulse repetition frequency, and coherency. This is an excellent resource for engineering professionals working in areas of radar signal processing and imaging as well as students interested in studying SAR.

Radar Signal Processing and Its Applications brings together in one place important contributions and up-to-date research results in this fast-moving area. In twelve selected chapters, it describes the latest advances in architectures, design methods, and applications of radar signal processing. The contributors to this work were selected from the leading researchers and practitioners in the field. This work, originally published as Volume 14, Numbers 1-3 of the journal, Multidimensional Systems and Signal Processing, will be valuable to anyone working or researching in the field of radar signal processing. It serves as an excellent reference, providing insight into some of the most challenging issues being examined today.

Synthetic Aperture Radar Processing simply and methodically presents principles and techniques of Synthetic Aperture Radar (SAR) image generation by analyzing its system transfer function. The text considers the full array of operation modes from strip to scan, emphasizes processing techniques, enabling the design of operational SAR codes. A simple example then follows. This book will be invaluable to all SAR scientists and engineers working in the field. It may be used as the basis for a course on SAR image generation or as a reference book on remote sensing. It contains a wide spectrum of information presented with clarity and rigor.

?The book gives an excellent theoretical and practical background of SAR in general and specifically of spotlight SAR. The rich experience of the authors in spotlight SAR processing is reflected by a very detailed summary of the associated theory as well as a lot of SAR image examples. These images illustrate the techniques described in the book and provide a valuable connection to practice. This book can be highly recommended to all scientists and engineers involved in SAR system design and SAR data evaluation.?---International Journal of Electronics and Communications

Describing a field that has been transformed by the recent availability of data from a new generation of space and airborne systems, the authors offer a synthetic geometrical approach to the description of synthetic aperture radar, one that addresses physicists, radar specialists, as well as experts in image processing.

This resource introduces a new image formation algorithm based on time-frequency-transforms, showing its advantage over the more conventional Fourier-based image formation. Referenced with over 170 equations and 80 illustrations, the book presents new algorithms that help improve the result of radar imaging and signal processing.

The use of synthetic aperture radar (SAR) represents a new era in remote sensing technology. A complete handbook for anyone who must design an SAR system capable of reliably producing high quality image data products, free from image artifacts and calibrated in terms of the target backscatter coefficient. Combines fundamentals underlying the SAR imaging process and the practical system engineering required to produce quality images from a real SAR system. Beginning with a broad overview of SAR technology, it goes on to examine SAR system capabilities and components and detail the techniques required for design and development of the SAR ground data system with emphasis on the correlation processing. Intended for SAR system engineers and researchers, it is generously illustrated for maximum clarity.

Radar, like most well developed areas, has its own vocabulary. Words like Doppler frequency, pulse compression, mismatched filter, carrier frequency, in-phase, and quadrature have specific meaning to the radar engineer. In fact, the word radar is actually an acronym for RAdio Detection And Ranging. Even though these words are well defined, they can act as road blocks which keep people without a radar background from utilizing the large amount of data, literature, and expertise within the radar community. This is unfortunate because the use of digital radar processing techniques has made possible the analysis of radar signals on many general purpose digi tal computers. Of special interest are the surface mapping radars, such as the Seasat and the shuttle imaging radars, which utilize a technique known as synthetic aperture radar (SAR) to create high resolution images (pic tures). This data appeals to cartographers, agronomists, oceanographers, and others who want to perform image enhancement, parameter estima tion, pattern recognition, and other information extraction techniques on the radar imagery. The first chapter presents the basics of radar processing:

techniques for calculating range (distance) by measuring round trip propagation times for radar pulses. This is the same technique that sightseers use when calculat ing the width of a canyon by timing the round trip delay using echoes. In fact, the corresponding approach in radar is usually called the pulse echo technique.

Written for students, remote sensing specialists, researchers and SAR system designers, Processing of SAR Data shows how to produce quality SAR images. In particular, this practical reference presents new methods and algorithms concerning the interferometric processing of SAR data with emphasis on system and signal theory, namely how SAR imagery is formed, how interferometry SAR images are created, and a detailed mathematical description of different focussing algorithms. Starting with the processing basics and progressing to the final geo-coded SAR data product, the book describes the complete processing steps in detail. Algorithms based on the effects of side-looking geometry are developed to correct foreshortening, shadowing and layover.

Advances in DSP (digital signal processing) have radically altered the design and usage of radar systems -- making it essential for both working engineers as well as students to master DSP techniques. This text, which evolved from the author's own teaching, offers a rigorous, in-depth introduction to today's complex radar DSP technologies. Contents: Introduction to Radar Systems * Signal Models * Sampling and Quantization of Pulsed Radar Signals * Radar Waveforms * Pulse Compression Waveforms * Doppler Processing * Detection Fundamentals * Constant False Alarm Rate (CFAR) Detection * Introduction to Synthetic Aperture Imaging

This open access book focuses on the practical application of electromagnetic polarimetry principles in Earth remote sensing with an educational purpose. In the last decade, the operations from fully polarimetric synthetic aperture radar such as the Japanese ALOS/PalSAR, the Canadian Radarsat-2 and the German TerraSAR-X and their easy data access for scientific use have developed further the research and data applications at L,C and X band. As a consequence, the wider distribution of polarimetric data sets across the remote sensing community boosted activity and development in polarimetric SAR applications, also in view of future missions. Numerous experiments with real data from spaceborne platforms are shown, with the aim of giving an up-to-date and complete treatment of the unique benefits of fully polarimetric synthetic aperture radar data in five different domains: forest, agriculture, cryosphere, urban and oceans.

An up-to-date analysis of the SAR wavefront reconstruction signal theory and its digital implementation With the advent of fast computing and digital information processing techniques, synthetic aperture radar (SAR) technology has become both more powerful and more accurate. Synthetic Aperture Radar Signal Processing with MATLAB Algorithms addresses these recent developments, providing a complete, up-to-date analysis of SAR and its associated digital signal processing algorithms. This book introduces the wavefront reconstruction signal theory that underlies the best SAR imaging methods and provides clear guidelines to system design, implementation, and applications in diverse areas-from airborne reconnaissance to topographic imaging of ocean floors to surveillance and air traffic control to medical imaging techniques, and numerous others. Enabling professionals in radar signal and image processing to use synthetic aperture technology to its fullest potential, this work: * Includes M-files to supplement this book that can be retrieved from The MathWorks anonymous FTP server at ftp://ftp.mathworks.com/pub/books/soumekh * Provides practical examples and results from real SAR, ISAR, and CSAR databases * Outlines unique properties of the SAR signal that cannot be found in other information processing systems * Examines spotlight SAR, stripmap SAR, circular SAR, and monopulse SAR modalities * Discusses classical SAR processing issues such as motion compensation and radar calibration

Radar has been an important topic since its introduction, in a military context, during World War II. Due to advances in technology, it has been necessary to refine the algorithms employed within the signal processing architecture. Hence, this book provides a series of chapters examining some topics in modern radar signal processing. These include synthetic aperture radar, multiple-input multiple-output radar, as well as a series of chapters examining other key issues relevant to the central theme of the book.

An authoritative work on Synthetic Aperture Radar system engineering, with key focus on high resolution imaging, moving target indication, and system engineering technology Synthetic Aperture Radar (SAR) is a powerful microwave remote sensing technique that is used to create high resolution two or three-dimensional representations of objects, such as landscapes, independent of weather conditions and sunlight illumination. SAR technology is a multidisciplinary field that involves microwave technology, antenna technology, signal processing, and image information processing. The use of SAR technology continues grow at a rapid pace in a variety of applications such as high-resolution wide-swath observation, multi-azimuth information acquisition, high-temporal information acquisition, 3-D terrain mapping, and image quality improvement. Design Technology of Synthetic Aperture Radar provides detailed coverage of the fundamental concepts, theories, technology, and design of SAR systems and sub-systems. Supported by the author's over two decades of research and practice experience in the field, this in-depth volume systematically describes SAR design and presents the latest research developments. Providing examination of all topics relevant to SAR—from radar and antenna system design to receiver technology and signal and image information processing—this comprehensive resource: Provides wide-ranging, up-to-date examination of all major topics related to SAR science, systems, and software Includes guidelines to conduct grounding system designs and analysis Offers coverage of all SAR algorithm classes and detailed SAR algorithms suitable for enabling software implementations Surveys SAR and computed imaging literature of the last sixty years Emphasizes high resolution imaging, moving target indication, and system engineering Design Technology of Synthetic Aperture Radar is indispensable for graduate students majoring in SAR system design, microwave antenna, signal and information processing as well as engineers and technicians involved in SAR system techniques.