

# Synthetic Aperture Radar Signal Processing With Ma

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## MCNEIL BAKER

**Synthetic Aperture Radar** Artech House on Demand

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

**Geosynchronous SAR: System and Signal Processing** John Wiley & Sons

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.

**Time-frequency Analysis of Synthetic Aperture Radar Signals** Artech House Publishers

This book chiefly addresses the analysis and design of geosynchronous synthetic aperture radar (GEO SAR) systems, focusing on the algorithms,

analysis, methods used to compensate for ionospheric influences, and validation experiments for Global Navigation Satellite Systems (GNSS). Further, it investigates special problems in the GEO SAR context, such as curved trajectories, the Earth's rotation, the 'non-stop-and-go' model, high-order Doppler parameters, temporal-variant ionospheric errors etc. These studies can also be extended to SAR with very high resolution and long integration time. Given the breadth and depth of its coverage, scientists and engineers in SAR and advanced graduate students in related areas will greatly benefit from this book.

**Study on Ground Moving Target Indication and Imaging Technique of Airborne SAR** Artech House Publishers

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.

**Transionospheric Synthetic Aperture Imaging** Wiley-Interscience

This book discusses statistical modeling of single- and multi-channel synthetic aperture radar (SAR) images and the applications of these newly

developed models in land and ocean monitoring, such as target detection and terrain classification. It is a valuable reference for researchers and engineers interested in information processing of remote sensing, radar signal processing, and image interpretation.

**Bistatic SAR System and Signal Processing Technology** Springer Science & Business Media

A comprehensive resource on airborne synthetic aperture radar (SAR) systems, Airborne Circularly Polarized SAR explains the theory, system design, hardware and software, and applications of airborne circularly polarized SAR in environmental monitoring and other uses. Readers learn how to build the hardware and software of circularly polarized SAR, the antenna system, and how to generate point target responses and images using the range doppler algorithm (RDA) from raw signal data. The book discusses applications and analyzing techniques using a circularly polarized SAR system and image processing. Images and MATLAB® codes are provided to help professionals and researchers with their applications and future studies. Features 1. Provides the theory of circularly polarized wave and polarimetry related to system design, scattering analysis, polarimetric SAR, and applications in microwave remote sensing. 2. Explains the real radio frequency (RF) system and the original antenna, including circuit explanation and know-how of measurement technique to adjust to the required parameter in system design. 3. Discusses the technique of ground test and flight mission to calibrate and validate the performance of airborne circularly polarized SAR. 4. Highlights image signal processing with MATLAB codes and how to obtain a single look complex (SLC) image for further applications. 5. Includes several applications of airborne circularly polarized SAR from international leading experts. This book is beneficial to professionals, researchers, academics, and graduate students from disciplines such as Electronic Engineering; Radar Systems; Aerospace Engineering; Signal Processing; Image Processing; Environmental Remote Sensing.

**Spotlight-Mode Synthetic Aperture Radar: A Signal Processing Approach** Springer

Although the field of sparse representations is relatively new, research activities in academic and industrial research labs are already producing encouraging results. The sparse signal or parameter model motivated several researchers and practitioners to explore high complexity/wide bandwidth applications such as Digital TV, MRI processing, and certain defense applications. The potential signal processing advancements in this area may influence radar technologies. This book presents the basic mathematical concepts along with a number of useful MATLAB® examples to emphasize the practical implementations both inside and outside the radar field. Table of Contents: Radar Systems: A Signal Processing Perspective / Introduction to Sparse Representations / Dimensionality Reduction / Radar Signal Processing Fundamentals / Sparse Representations in Radar *Signal Processing in Noise Waveform Radar* CRC Press

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

*Processing of Synthetic Aperture Radar (SAR) Images* John Wiley & Sons

The following topics are dealt with: ISAR imaging; ISAR motion compensation; ISAR autofocus algorithm; signal processing; ISAR target feature extraction; refocusing moving target; FMCW ISAR; bistatic ISAR; and polarimetric ISAR.

*Topics in Radar Signal Processing* Springer

Although the field of sparse representations is relatively new, research activities in academic and industrial research labs are already producing encouraging results. The sparse signal or parameter model motivated several researchers and practitioners to explore high complexity/wide bandwidth applications such as Digital TV, MRI processing, and certain defense applications. The potential signal processing advancements in this area may influence radar technologies. This book presents the basic mathematical concepts along with a number of useful MATLAB® examples to emphasize the practical implementations both inside and outside the radar field. Table of Contents: Radar Systems: A Signal Processing Perspective / Introduction to Sparse Representations / Dimensionality Reduction / Radar Signal Processing Fundamentals / Sparse Representations in Radar *Digital Processing of Synthetic Aperture Radar Data* Springer

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. The FFBP method of processing, explicit treatment of base 2 FFBP is explained along with motion errors sensitivity and motion estimation methods. The book also explains the Bayesian change detection, covariance moving target extraction and polarimetric subsurface imaging.

*Synthetic Aperture Radar* Wiley-Interscience

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.

*Radar Signal Processing and Its Applications* John Wiley & Sons

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 Rang ing. 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 digital 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 (pictures). This data appeals to cartographers, agronomists, oceanographers, and others who want to perform image enhancement, parameter estimation, 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 calculating 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.

**Multi-Dimensional Imaging with Synthetic Aperture Radar** Artech House

This landmark monograph presents the most recent mathematical developments in the analysis of ionospheric distortions of SAR images and offers innovative new strategies for their mitigation. As a prerequisite to addressing these topics, the book also discusses the radar ambiguity theory as it applies to synthetic aperture imaging and the propagation of radio waves through the ionospheric plasma, including the anisotropic and turbulent cases. In addition, it covers a host of related subjects, such as the mathematical modeling of extended radar targets (as opposed to point-wise targets) and the scattering of radio waves off those targets, as well as the theoretical analysis of the start-stop approximation, which is used routinely in SAR signal processing but often without proper justification. The mathematics in this volume is clean and rigorous – no assumptions are hidden or ambiguously stated. The resulting work is truly interdisciplinary, providing both a comprehensive and thorough exposition of the field, as well as an accurate account of a range of relevant physical processes and phenomena. The book is intended for applied mathematicians interested in the area of radar imaging or, more generally, remote sensing, as well as physicists and electrical/electronic engineers who develop/operate spaceborne SAR sensors and perform the data processing. The methods in the book are also useful for researchers and practitioners working on other types of imaging. Moreover, the book is accessible to graduate students in applied mathematics, physics, engineering, and related disciplines. Praise for Transionospheric Synthetic Aperture Imaging: “I perceive that this text will mark a turning point in the field of synthetic aperture radar research and practice. I believe this text will instigate a new era of more rigorous image formation relieving the research, development and practitioner communities of inconsistent physical assumptions and numerical approaches.” – Richard Albanese, Senior Scientist, Albanese Defense and Energy Development LLC

**Time-frequency Transforms for Radar Imaging and Signal Analysis** CRC Press

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.

*Bistatic SAR Data Processing Algorithms* Artech House

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.

**Meter-Wave Synthetic Aperture Radar for Concealed Object Detection** Elsevier

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 on to 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 complicated SAR Sample image synthesis exercises are available from the book's companion site

[Sparse Representations for Radar with MATLAB® Examples](#) Springer

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

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[Polarimetric Synthetic Aperture Radar](#) John Wiley & Sons

Based on a detailed analysis of the signal model of the moving target, this thesis focuses on the theories and applications of ground moving target indicator (GMTI) and ground moving target imaging (GMTIm) algorithms in synthetic aperture radar/ ground moving target indicator (SAR/GMTI mode), wide-area surveillance ground moving target indication (WAS-GMTI) mode and frequency modulated continuous wave synthetic aperture radar (FMCW SAR) systems. The proposed algorithms can not only indicate and image fast-moving targets, but are also effective in the context of slow-moving target processing. The system design scheme combines the mechanical scanning mode and the airborne SAR system, while the azimuth moving target indication algorithm employs the additional range walk migration induced by FMCW SAR systems. In addition, the non-ideal errors that deteriorate the performance of GMTIm algorithms in real SAR data processing are discussed, and suitable compensation methods are provided.>

[Synthetic Aperture Radar Signal Processing with MATLAB Algorithms](#) Morgan & Claypool Publishers

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.