Spotlight Mode Synthetic Aperture Radar A Signal Processing Approach

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.>

IFP V4.0 is the fourth generation of an extraordinarily powerful and flexible image formation processor for spotlight mode synthetic aperture radar. It has been successfully utilized in processing phase histories from numerous radars and has been instrumental in the development of many new capabilities for spotlight mode SAR. This document provides a brief history of the development of IFP, a full exposition of the signal processing steps involved, and a short user's manual for the software implementing this latest iteration.

This book presents a novel non-intrusive infrastructure monitoring technique based on the detection and tracking of scattering centers in spaceborne SAR images. The methodology essentially consists of refocusing each available SAR image on an imposed 3D point cloud associated to the envisaged infrastructure element and identifying the reliable scatterers to be monitored by means of four dimensional (4D) tomography. The methodology described in this book provides a new perspective on infrastructure monitoring with spaceborne SAR images, is based on a standalone processing chain, and brings innovative technical aspects relative to conventional approaches. The book is intended primarily for professionals and researchers working in the area of critical infrastructure monitoring by radar remote sensing.

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 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.

The present work deals with a highly resolved radar with a synthetic aperture (synthetic aperture radar - SAR), which uses a beam steering to improve performance. The first part of this work deals with the influence of various effects occurring in the hardware of the High-Resolution Wide-Swath SAR (HRWS SAR) system. A special focus was set to single bit quantization in multi-channel receiver. The second part of this work describes SAR processors for Sliding Spotlight mode. This work was published by Saint Philip Street Press pursuant to a Creative Commons license permitting commercial use. All rights not granted by the work's license are retained by the author or authors.

Synthetic Aperture Radar (SAR) is a radar imaging technique that is used to collect data about targets. These targets are typically landscapes, buildings and other planets. Since SAR can operate in any weather condition and during any time of day, it is a useful tool for military and scientific purposes. To collect the data, a radar is placed on one side of an aircraft while the aircraft hovers over the desired target. Spotlight-mode SAR, an operation mode of SAR, is capable of producing high-resolution images of targets as this method focuses only at one area of the target at a time. Magnetic Resonance Imaging (MRI), on the other hand, is a popular medical imaging technique. MRI acquires data to produce images of a body's organs, tissues and skeletal system. The interactions between applied magnetic fields and nuclear spins are used to reconstruct images of a body's internal organs and tissues. This thesis project focuses on the analysis of the data acquisition processes that take place in spotlight-mode SAR and MRI.

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.

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.

"Spotlight-mode Synthetic Aperture Radar: A Signal Processing Approach describes an important mode of synthetic aperture radar (SAR) imaging, known as spotlight-mode SAR. By treating the subject via the principles of signal processing, this book allows those individuals who are not schooled in the specialized (and sometimes confusing) language of radar imaging to gain accessibility to the critical ideas of SAR relatively quickly. An understanding of basic signal processing concepts (Fourier transforms, convolution, filtering, etc.) is the only required background." "The first two chapters of the book develop a rigorous theoretical framework for spotlight-mode SAR, using a paradigm based on three-dimensional tomographic concepts. Following that, a chapter is devoted to the various signal processing steps that are required for robust spotlight-mode image formation via the polar-reformatting algorithm. Numerous examples, derived from simulated as well as real spotlight-mode imagery, are employed to clearly demonstrate the important concepts. Chapter 4 then discusses the effects of phase errors on spotlight-mode SAR imagery, and describes various algorithms for automatic phase error correction, also known as autofocus. The widely used technique of Phase Gradient Autofocus (PGA) is analyzed in depth and a variety of results from actual SAR imagery are shown. The final chapter discusses the subject of interferometry from spotlight-mode SAR imagery. This important topic is currently the subject of extensive research and development efforts across the international SAR community." "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 will find the book useful as a reference."--BOOK JACKET.

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.

A timely and authoritative guide to the state of the art of wavescattering Scattering of Electromagnetic Waves offers in three volumes acomplete and up-to-date treatment of wave scattering by randomdiscrete scatterers and rough surfaces. Written by leadingscientists who have made important contributions to wave scatteringover three decades, this new work explains the principles, methods,and applications of this rapidly expanding, interdisciplinaryfield. It covers both introductory and advanced material andprovides students and researchers in remote sensing as well asimaging, optics, and electromagnetic theory with a one-stopreference to a wealth of current research results. Plus, Scatteringof Electromagnetic Waves contains detailed discussions of bothanalytical and numerical methods, including cutting-edge techniquesfor the recovery of earth/land parametric information. The three volumes are entitled respectively Theories andApplications, Numerical Simulation, and Advanced Topics. In thefirst volume, Theories and Applications, Leung Tsang (University ofWashington) Jin Au Kong (MIT), and Kung-Hau Ding (Air ForceResearch Lab) cover: * Basic theory of electromagnetic scattering * Fundamentals of random scattering * Characteristics of discrete scatterers and rough surfaces * Scattering and emission by layered media * Single scattering and applications * Radiative transfer theory and solution techniques * One-dimensional random rough surface scattering

Because of its ability to sense the Earth's surface at night and during the day, under any weather condition, Synthetic Aperture Radar (SAR) has become a well-established and powerful remote sensing technology that is used worldwide for numerous applications. This book compiles 19 research works that investigate different aspects of SAR processing, SAR image analysis, and SAR applications. The contributions cover topics related to multi-angle/wide-angle SAR imaging; Doppler parameter estimation; data-driven focusing; Inverse SAR (ISAR) applied to pulsar signal modeling and detection; ground-based SAR; near-field interferometric ISAR; the interaction between SAR signals and the Infosphere; SAR interferometry for ground displacement monitoring, feature extraction, and change detection; and SAR-based sea applications. The selected studies represent real examples of the abundant research ongoing in the field of SAR processing and applications, and they further demonstrate that SAR imaging still presents considerable opportunities for future investigation.

Advances in Bistatic Radar updates and extends bistatic and multistatic radar developments since the publication of Willis' Bistatic Radar in 1991. New and recently declassified military applications are documented, civil applications are detailed including

commercial and scientific systems and leading radar engineers provide expertise to each of these applications. Advances in Bistatic Radar consists of two major sections: Bistatic/Multistatic Radar Systems and Bistatic Clutter and Signal Processing. Starting with a history update, the first section documents the early and now declassified military AN/FPS-23 Fluttar DEW-Line Gap-filler, and high frequency (HF) bistatic radars developed for missile attack warning. It then documents the recently developed passive bistatic and multistatic radars exploiting commercial broadcast transmitters for military and civilian air surveillance. Next, the section documents scientific bistatic radar systems for planetary exploration, which have exploited data link transmitters over the last forty years; ionospheric measurements, again exploiting commercial broadcast transmitters; and 3-D wind field measurements using a bistatic receiver hitchhiking off doppler weather radars. This last application has been commercialized. The second section starts by documenting the full, unclassified bistatic clutter scattering coefficient data base, along with the theory and analysis supporting its development. The section then details two major clutter-related developments, spotlight bistatic synthetic aperture radar (SAR), which can now generate high resolution images using bistatic autofocus and related techniques; and adaptive moving target indication (MTI), which allows cancellation of nonstationary clutter generated by moving (i.e. airborne) platforms through the use of bistatic space-time adaptive processing (STAP).

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.

Spotlight-Mode Synthetic Aperture Radar: A Signal Processing ApproachA Signal Processing ApproachSpringer Science & Business Media

?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

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

The first edition of the Encyclopedia of Optical and Photonic Engineering provided a valuable reference concerning devices or systems that generate, transmit, measure, or detect light, and to a lesser degree, the basic interaction of light and matter. This Second Edition not only reflects the changes in optical and photonic engineering that have occurred since the first edition was published, but also: Boasts a wealth of new material, expanding the encyclopedia’s length by 25 percent Contains extensive updates, with significant revisions made throughout the text Features contributions from engineers and scientists leading the fields of optics and photonics today With the addition of a second editor, the Encyclopedia of Optical and Photonic Engineering, Second Edition offers a balanced and up-to-date look at the fundamentals of a diverse portfolio of technologies and discoveries in areas ranging from x-ray optics to photon entanglement and beyond. This edition’s release corresponds nicely with the United Nations General Assembly’s declaration of 2015 as the International Year of Light, working in tandem to raise awareness about light’s important role in the modern world. Also Available Online This Taylor & Francis encyclopedia is also available through online subscription, offering a variety of extra benefits for researchers, students, and librarians, including: Citation tracking and alerts Active reference linking Saved searches and marked lists HTML and PDF format options Contact Taylor and Francis for more information or to inquire about subscription options and print/online combination packages. US: (Tel) 1.888.318.2367; (E-mail) e-reference@taylorandfrancis.com International: (Tel) +44 (0) 20 7017 6062; (E-mail) online.sales@tandf.co.uk

Compiled by 330 of the most widely respected names in the electro-optical sciences, the Encyclopedia is destined to serve as the premiere guide in the field with nearly 2000 figures, 560 photographs, 260 tables, and 3800 equations. From astronomy to x-ray optics, this reference contains more than 230 vivid entries examining the most intriguing technological advances and perspectives from distinguished professionals around the globe. The contributors have selected topics of utmost importance in areas including digital image enhancement, biological modeling, biomedical spectroscopy, and ocean optics, providing thorough coverage of recent applications in this continually expanding field.

Synthetic Aperture Radar (SAR) is critical for remote sensing.It works day and night, in good weather or bad. Bistatic SAR is anew kind of

SAR system, where the transmitter and receiver areplaced on two separate platforms. Bistatic SAR is one of the mostimportant trends in SAR development, as the technology renders SARmore flexible and safer when used in military environments. Imagingis one of the most difficult and important aspects of bistatic SARdata processing. Although traditional SAR signal processing isfully developed, bistatic SAR has a more complex system structure,so signal processing is more challenging. Focusing on imagingaspects of bistatic SAR signal processing, this book coversresolution analysis, echo generation methods, imaging algorithms,imaging parameter estimation, and motion compensation methods. The book is ideal for researchers and engineers in SAR signaland data processing, as well as those working in bistatic andmultistatic radar imaging, and in the radar sciences. Graduate students with a background in radar who are interested inbistatic and multistatic radar will find this book a helpfulreference. Gives a general and updated framework for image formation usingsignal processing aspects Starts with an introduction to traditional SAR before moving onto more advanced topics Offers readers a range of exhaustive tools to process signalsand form images Provides a solid reference for the imaging of other complicatedSAR Sample image synthesis exercises are available from the book'scompanion site

Spotlight mode synthetic aperture radar (SAR) imaging involves a tomo- graphic reconstruction from projections, necessitating acquisition of large amounts of data in order to form a moderately sized image. Since typical SAR sensors are hosted on mobile platforms, it is common to have limitations on SAR data acquisi- tion, storage and communication that can lead to data corruption and a resulting degradation of image quality. It is convenient to consider corrupted samples as missing, creating a sparsely sampled aperture. A sparse aperture would also result from compressive sensing, which is a very attractive concept for data intensive sen- sors such as SAR. Recent developments in sparse decomposition algorithms can be applied to the problem of SAR image formation from a sparsely sampled aperture. Two modified sparse decomposition algorithms are developed, based on well known existing algorithms, modified to be practical in application on modest computa- tional resources. The two algorithms are demonstrated on real-world SAR images. Algorithm performance with respect to super-resolution, noise, coherent speckle and target/clutter decomposition is explored. These algorithms yield more accu- rate image reconstruction from sparsely sampled apertures than classical spectral estimators. At the current state of development, sparse image reconstruction using these two algorithms require about two orders of magnitude greater processing time than classical SAR image formation.

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.

This book is a printed edition of the Special Issue "Advances in SAR: Sensors, Methodologies, and Applications" that was published in Remote Sensing

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

Based on the experiences of the Department of Information Engineering of the University of Pisa and the Radar and Surveillance System (RaSS) national laboratory of the National Interuniversity Consortium of Telecommunication (CNIT), Radar Imaging for Maritime Observation presents the most recent results in radar imaging for maritime observation. The book explores both the areas of sea surface remote sensing and maritime surveillance providing key theoretical concepts of SAR and ISAR imaging and more advanced and ad-hoc techniques for applications in maritime scenarios. The book is organized in two sections. The first section discusses the fundamentals of standard SAR/ISAR processing and novel imaging techniques, such as Bistatic, Passive, and, 3D Interferometric ISAR. The second section focuses on the applications and results obtained by processing real data from maritime observations like SAR image processing for oil spill, detection in SAR images and fractal analysis. Useful to both beginners and experts in maritime observation, this book provides several examples of (mainly space-borne) radar imaging of maritime targets. Nevertheless, the same principles and techniques apply to the case of manned or unmanned carriers and to ground and air moving targets.

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.

This book comprehensively describes high-resolution microwave imaging and super-resolution information processing technologies and discusses new theories, methods and achievements in the high-resolution microwave imaging fields. Its chapters, which include abundant research results and examples, systematically summarize the authors’ main research findings in recent years. The book is intended for researchers, engineers and postgraduates in the fields of electronics systems, signal information processing and data analysis, microwave remote sensing and microwave imaging radar, as well as space technology, especially in the microwave remote sensing and airborne or space-borne microwave imaging radar fields.

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.