

Digital Processing Of Synthetic Aperture Radar Data Algorithms And Implementation With Cdrom Artech House

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first published in france in 2001 by hermes science publications entitled traitement des images de rso t p verso

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

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

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

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 delivers a comprehensive introduction to the principles and applications of synthetic aperture radar sar for measuring and monitoring surface motion caused by a wide range of geophysical phenomena such as earthquakes volcanoes urban subsidence and landslides along with covering essential sar concepts like the radar equation resolution and signal processing techniques such as focusing and interferometry the book provides an in depth exploration of advanced methodologies including psinsar stn psp stamps sbas qps and squeesar all critical for tracking long term surface deformation techniques such as pixel offset tracking and sar based absolute positioning are also thoroughly introduced with illustrative examples provided to enhance understanding each step of these techniques is clearly explained breaking down complex topics for readers additionally a vivid case study on ship detection illustrates sar imaging principles and targets scattering characteristics offering a strong foundation for sar based measurement techniques written in an accessible and clear style the book features numerous real world examples and case studies drawn from modern sar missions like sentinel 1 and terrasar x effectively bridging the gap between theoretical foundations and practical applications this valuable reference is ideal for graduate students researchers and professionals in the fields of remote sensing geodesy geosciences and engineering providing not only essential foundational knowledge but also insights into the latest technological advancements in surface motion monitoring

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 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

this carefully curated volume presents an in depth state of the art discussion on many applications of synthetic aperture radar sar integrating interdisciplinary sciences the book features novel ideas quantitative methods and research results promising to advance computational practices and technologies within the academic and industrial communities sar applications employ diverse and often complex computational methods rooted in machine learning estimation statistical learning inversion models and empirical models current and emerging applications of sar data for earth observation object detection and recognition change detection navigation and interference mitigation are highlighted cutting edge methods with particular emphasis on machine learning are included contemporary deep learning models in object detection and recognition in

sar imagery with corresponding feature extraction and training schemes are considered state of the art neural network architectures in sar aided navigation are compared and discussed further advanced empirical and machine learning models in retrieving land and ocean information wind wave soil conditions among others are also included

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

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 operati

synthetic aperture radar provides broad area imaging at high resolutions which is used in applications such as environmental monitoring earth resource mapping and military systems this book presents the tools required for the digital processing of synthetic aperture radar images they are of three types a the elements of physics b mathematical models and c image processing methods adapted to particular applications

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

this book provides basic and advanced concepts of synthetic aperture radar sar polsar insar polinsar and all necessary information about various applications and analysis of data of multiple sensors it includes information on sar remote sensing data processing and separate applications of sar technology compiled in one place it will help readers to use active microwave imaging sensor based information in geospatial technology and applications this book covers basic and advanced concepts of synthetic aperture radar sar remote sensing introduces spaceborne sar sensors discusses applications of sar remote sensing in earth observation explores utilization of sar data for solid earth ecosystem and cryosphere including imaging of extra terrestrial bodies includes polsar and polinsar for aboveground forest biomass retrieval as well as insar and polsar for snow parameters retrieval this book is aimed at researchers and graduate students in remote sensing photogrammetry geoscience image processing agriculture environment forestry and image processing

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 transitionospheric 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

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 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

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