

## Jensen Hyperspectral Image Analysis Chapter 11

Throughout much of machine vision's early years the infrared imagery has suffered from return on investment despite its advantages over visual counterparts. Recently, the ?scal momentum has switched in favor of both manufacturers and practitioners of infrared technology as a result of today's rising security and safety challenges and advances in thermographic sensors and their continuous drop in costs. This yielded a great impetus in achieving ever better performance in remote surveillance, object recognition, guidance, noncontact medical measurements, and more. The purpose of this book is to draw attention to recent successful efforts made on merging computer vision applications (nonmilitary only) and nonvisual imagery, as well as to ?ll in the need in the literature for an up-to-date convenient reference on machine vision and infrared technologies. *Augmented Perception in Infrared* provides a comprehensive review of recent deployment of infrared sensors in modern applications of computer vision, along with in-depth description of the world's best machine vision algorithms and intel- gent analytics. Its topics encompass many disciplines of machine vision, including remote sensing, automatic target detection and recognition, background modeling and image segmentation, object tracking, face and facial expression recognition, - variant shape characterization, disparate sensors fusion, noncontact physiological measurements, night vision, and target classi?cation. Its application scope includes homeland security, public transportation, surveillance, medical, and military. Mo- over, this book emphasizes the merging of the aforementioned machine perception applications and nonvisual imaging in intensi?ed, near infrared, thermal infrared, laser, polarimetric, and hyperspectral bands.

Remote Sensing image analysis is mostly done using only spectral information on a pixel by pixel basis. Information captured in neighbouring cells, or information about patterns surrounding the pixel of interest often provides useful supplementary information. This book presents a wide range of innovative and advanced image processing methods for including spatial information, captured by neighbouring pixels in remotely sensed images, to improve image interpretation or image classification. Presented methods include different types of variogram analysis, various methods for texture quantification, smart kernel operators, pattern recognition techniques, image segmentation methods, sub-pixel methods, wavelets and advanced spectral mixture analysis techniques. Apart from explaining the working methods in detail a wide range of applications is presented covering land cover and land use mapping, environmental applications such as heavy metal pollution, urban mapping and geological applications to detect hydrocarbon seeps. The book is meant for professionals, PhD students and graduates who use remote sensing image analysis, image interpretation and image classification in their work related to disciplines such as geography, geology, botany, ecology, forestry, cartography, soil science, engineering and

*urban and regional planning.*

*Written by leading global experts, including pioneers in the field, the four-volume set on Hyperspectral Remote Sensing of Vegetation, Second Edition, reviews existing state-of-the-art knowledge, highlights advances made in different areas, and provides guidance for the appropriate use of hyperspectral data in the study and management of agricultural crops and natural vegetation. Volume II, Hyperspectral Indices and Image Classifications for Agriculture and Vegetation evaluates the performance of hyperspectral narrowband or imaging spectroscopy data with specific emphasis on the uses and applications of hyperspectral narrowband vegetation indices in characterizing, modeling, mapping, and monitoring agricultural crops and vegetation. This volume presents and discusses topics such as the non-invasive quantification of foliar pigments, leaf nitrogen concentration of cereal crop, the estimation of nitrogen content in crops and pastures, and forest leaf chlorophyll content, among others. The concluding chapter provides readers with useful guidance on the highlights and essence of Volume II through the editors' perspective. Key Features of Volume II: Provides the fundamentals of hyperspectral narrowband vegetation indices and hyperspectral derivative vegetation indices and their applications in agriculture and vegetation studies. Discusses the latest advances in hyperspectral image classification methods and their applications. Explains the massively big hyperspectral sensing data processing on cloud computing architectures. Highlights the state-of-the-art methods in the field of hyperspectral narrowband vegetation indices for monitoring agriculture, vegetation, and their properties such as plant water content, nitrogen, chlorophyll, and others at leaf, canopy, field, and landscape scales. Includes best global expertise on hyperspectral remote sensing of agriculture, crop water use, plant species detection, crop productivity and water productivity mapping, and modeling.*

*Further Developments in the Theory and Practice of Cybercartography, Third Edition, Volume Nine, presents a substantively updated edition of a classic text on cybercartography, presenting new and returning readers alike with the latest advances in the field. The book examines the major elements of cybercartography and embraces an interactive, dynamic, multisensory format with the use of multimedia and multimodal interfaces. Material covering the major elements, key ideas and definitions of cybercartography is newly supplemented by several chapters on two emerging areas of study, including international dimensions and language mapping. This new edition delves deep into Mexico, Brazil, Denmark, Iran and Kyrgyzstan, demonstrating how insights emerge when cybercartography is applied in different cultural contexts. Meanwhile, other chapters contain case studies by a talented group of linguists who are breaking new ground by applying cybercartography to language mapping, a breakthrough that will provide new ways of understanding the distribution and movement of language and culture. Highlights the relationship between cybercartography and critical geography Incorporates the latest*

***developments in the field of cybercartography, including International Dimensions and Language Mapping Showcases the legal, ethical and policy implications of mapping local and traditional knowledge***

***Progress in Image Analysis and Processing, ICIAP 2013***

***Algorithms and Applied Systems***

***Introductory Digital Image Processing***

***International Dimensions and Language Mapping***

***Real-Time Recursive Hyperspectral Sample and Band Processing***

***An Introduction to Contemporary Remote Sensing***

Image Analysis, Classification and Change Detection in Remote Sensing: With Algorithms for ENVI/IDL and Python, Third Edition introduces techniques used in the processing of remote sensing digital imagery. It emphasizes the development and implementation of statistically motivated, data-driven techniques. The author achieves this by tightly interweaving theory, algorithms, and computer codes. See What's New in the Third Edition: Inclusion of extensive code in Python, with a cloud computing example New material on synthetic aperture radar (SAR) data analysis New illustrations in all chapters Extended theoretical development The material is self-contained and illustrated with many programming examples in IDL. The illustrations and applications in the text can be plugged in to the ENVI system in a completely transparent fashion and used immediately both for study and for processing of real imagery. The inclusion of Python-coded versions of the main image analysis algorithms discussed make it accessible to students and teachers without expensive ENVI/IDL licenses. Furthermore, Python platforms can take advantage of new cloud services that essentially provide unlimited computational power. The book covers both multispectral and polarimetric radar image analysis techniques in a way that makes both the differences and parallels clear and emphasizes the importance of choosing appropriate statistical methods. Each chapter concludes with exercises, some of which are small programming projects, intended to illustrate or justify the foregoing development, making this self-contained text ideal for self-study or classroom use.

The first of its kind, this book reviews image processing tools and techniques including Independent Component Analysis, Mutual Information, Markov Random Field Models and Support Vector Machines. The book also explores a number of experimental examples based on a variety of remote sensors. The book will be useful to people involved in hyperspectral imaging research, as well as by remote-sensing data like geologists, hydrologists, environmental scientists, civil engineers and computer scientists.

Optical remote sensing relies on exploiting multispectral and hyper spectral imagery possessing high spatial and spectral resolutions respectively. These modalities, although useful for most remote sensing tasks, often present challenges that must be addressed for their effective exploitation. This book presents current state-of-the-art algorithms that address the following key challenges encountered in representation and analysis of such optical remotely sensed data. Challenges in pre-processing images, storing and

representing high dimensional data, fusing different sensor modalities, pattern classification and target recognition, visualization of high dimensional imagery.

Hyperspectral Data Processing: Algorithm Design and Analysis is a culmination of the research conducted in the Remote Sensing Signal and Image Processing Laboratory (RSSIPL) at the University of Maryland, Baltimore County. Specifically, it treats hyperspectral image processing and hyperspectral signal processing as separate subjects in two different categories. Most materials covered in this book can be used in conjunction with the author's first book, Hyperspectral Imaging: Techniques for Spectral Detection and Classification, without much overlap. Many results in this book are either new or have not been explored, presented, or published in the public domain. These include various aspects of endmember extraction, unsupervised linear spectral mixture analysis, hyperspectral information compression, hyperspectral signal coding and characterization, as well as applications to conceal target detection, multispectral imaging, and magnetic resonance imaging. Hyperspectral Data Processing contains eight major sections: Part I: provides fundamentals of hyperspectral data processing Part II: offers various algorithm designs for endmember extraction Part III: derives theory for supervised linear spectral mixture analysis Part IV: designs unsupervised methods for hyperspectral image analysis Part V: explores new concepts on hyperspectral information compression Parts VI & VII: develops techniques for hyperspectral signal coding and characterization Part VIII: presents applications in multispectral imaging and magnetic resonance imaging Hyperspectral Data Processing compiles an algorithm compendium with MATLAB codes in an appendix to help readers implement many important algorithms developed in this book and write their own program codes without relying on software packages. Hyperspectral Data Processing is a valuable reference for those who have been involved with hyperspectral imaging and its techniques, as well as those who are new to the subject.

Endmember Finding and Anomaly Detection

Remote Sensing Image Analysis: Including the Spatial Domain  
With Algorithms for ENVI/IDL and Python, Third Edition

Handbook of Research on Emerging Perspectives in Intelligent Pattern  
Recognition, Analysis, and Image Processing

A Remote Sensing Perspective

Remote Sensing Digital Image Analysis

This university-level reference work covers a range of remote sensing techniques that are useful for mapping and visualizing benthic environments on continental shelves. Chapters focus on overviews of the history and future of seafloor mapping techniques, cartographical visualisation and communication of seafloor mapping, and practical applications of new technologies. Seabed mapping is referenced by high-resolution seismic methods, sidescan sonar, multibeam

bathymetry, satellite imagery, LiDAR, acoustic backscatter techniques, and soundscape ecology monitoring, use of autonomous underwater vehicles, among other methods. The wide breadth of subjects in this volume provides diversified coverage of seafloor imaging. This collection of modern seafloor mapping techniques summarizes the state of the art methods for mapping continental shelves.

Professionals in local and national government and in the private sector frequently need to draw on Geographical Information Systems (GIS), Remote Sensing (RS) and Global Positioning Systems (GPS), often in an integrated manner. This manual shows a hands-on operator how to work across the range of geospatial science and technology, whether as a user or as a contractor of services employing these technologies, and without either specialist education or substantial experience. The manual covers the fundamentals of each of these topical areas, providing the requisite mathematics, computer science and physics necessary to understand how the technologies work, assuming some elementary background in calculus and physics. It also shows how the technologies can be used together and focuses on their commonalities. A number of applications such as mapping and environmental modeling are presented, and a website accompanies the book.

Hyperspectral Image Processing Springer

Unmanned aircraft systems (UAS) are rapidly emerging as flexible platforms for capturing imagery and other data across the sciences. Many colleges and universities are developing courses on UAS-based data acquisition. Fundamentals of Capturing and Processing Drone Imagery and Data is a comprehensive, introductory text on how to use unmanned aircraft systems for data capture and analysis. It provides best practices for planning data capture missions and hands-on learning modules geared toward UAS data collection, processing, and applications. FEATURES Lays out a step-by-step approach to identify relevant tools and methods for UAS data/image acquisition and processing Provides practical hands-on knowledge with visual interpretation, well-organized and designed for a typical 16-week UAS course offered on college and university campuses Suitable for all levels of readers and does not require prior knowledge of UAS, remote sensing, digital image processing, or geospatial analytics Includes real-world environmental applications along with data interpretations and software used, often nonproprietary Combines the expertise of a wide range of UAS researchers and practitioners across the geospatial sciences This book provides a general introduction to drones along with a series of hands-on exercises that students and

researchers can engage with to learn to integrate drone data into real-world applications. No prior background in remote sensing, GIS, or drone knowledge is needed to use this book. Readers will learn to process different types of UAS imagery for applications (such as precision agriculture, forestry, urban landscapes) and apply this knowledge in environmental monitoring and land-use studies.

Manual of Geospatial Science and Technology

Hyperspectral Imaging

Classification Techniques for Earth Observation Imagery

Environmental Information Systems: Concepts, Methodologies, Tools, and Applications

Urban Sustainability: Policy and Praxis

Naples, Italy, September 9-13, 2013, Proceedings, Part I

With the widespread availability of satellite and aircraft remote sensing image data in digital form, and the ready access most remote sensing practitioners have to computing systems for image interpretation, there is a need to draw together the range of digital image processing procedures and methodologies commonly used in this field into a single treatment. It is the intention of this book to provide such a function, at a level meaningful to the non-specialist digital image analyst, but in sufficient detail that algorithm limitations, alternative procedures and current trends can be appreciated. Often the applications specialist in remote sensing wishing to make use of digital processing procedures has had to depend upon either the mathematically detailed treatments of image processing found in the electrical engineering and computer science literature, or the sometimes necessarily superficial treatments given in general texts on remote sensing. This book seeks to redress that situation. Both image enhancement and classification techniques are covered making the material relevant in those applications in which photointerpretation is used for information extraction and in those wherein information is obtained by classification.

"Remote Sensing of Urban and Suburban Areas" provides instructors with a text reference that has a logical and easy-to-follow flow of topics around which they can structure the syllabi of their urban remote sensing courses. Topics have been chosen to bridge the gap between remote sensing and urban studies through a better understanding of the science that underlies both fields. In so doing, the book includes 17 chapters written by leading international experts in respected fields to provide a balanced coverage of fundamental issues in both remote sensing and urban studies. Emphasis is placed on: theoretical and practical issues in contemporary urban studies and remote sensing; the spectral, spatial and temporal requirements of remotely sensed data in relation to various urban phenomena; methods and techniques for analyzing and integrating remotely sensed data and image processing with geographic information systems to address urban problems; and examples of applications in which applying remote sensing to tackle urban problems is deemed useful and important.

Polarized light is a pervasive influence in our world—and scientists and engineers in a variety of fields require the tools to understand, measure, and apply it to their advantage.

Offering an in-depth examination of the subject and a description of its applications, *Polarized Light, Third Edition* serves as a comprehensive self-study tool complete with an extensive mathematical analysis of the Mueller matrix and coverage of Maxwell's equations. Links Historical Developments to Current Applications and Future Innovations This book starts with a general description of light and continues with a complete exploration of polarized light, including how it is produced and its practical applications. The author incorporates basic topics, such as polarization by refraction and reflection, polarization elements, anisotropic materials, polarization formalisms (Mueller–Stokes and Jones) and associated mathematics, and polarimetry, or the science of polarization measurement. New to the Third Edition: A new introductory chapter Chapters on: polarized light in nature, and form birefringence A review of the history of polarized light, and a chapter on the interference laws of Fresnel and Arago—both completely re-written A new appendix on conventions used in polarized light New graphics, and black-and-white photos and color plates Divided into four parts, this book covers the fundamental concepts and theoretical framework of polarized light. Next, it thoroughly explores the science of polarimetry, followed by discussion of polarized light applications. The author concludes by discussing how our polarized light framework is applied to physics concepts, such as accelerating charges and quantum systems. Building on the solid foundation of the first two editions, this book reorganizes and updates existing material on fundamentals, theory, polarimetry, and applications. It adds new chapters, graphics, and color photos, as well as a new appendix on conventions used in polarized light. As a result, the author has re-established this book's lofty status in the pantheon of literature on this important field. 'A magnificent achievement. A who's who of contemporary remote sensing have produced an engaging, wide-ranging and scholarly review of the field in just one volume' - Professor Paul Curran, Vice-Chancellor, Bournemouth University Remote Sensing acquires and interprets small or large-scale data about the Earth from a distance. Using a wide range of spatial, spectral, temporal, and radiometric scales Remote Sensing is a large and diverse field for which this Handbook will be the key research reference. Organized in four key sections: • Interactions of Electromagnetic Radiation with the Terrestrial Environment: chapters on Visible, Near-IR and Shortwave IR; Middle IR (3-5 micrometers); Thermal IR ; Microwave • Digital sensors and Image Characteristics: chapters on Sensor Technology; Coarse Spatial Resolution Optical Sensors ; Medium Spatial Resolution Optical Sensors; Fine Spatial Resolution Optical Sensors; Video Imaging and Multispectral Digital Photography; Hyperspectral Sensors; Radar and Passive Microwave Sensors; Lidar • Remote Sensing Analysis - Design and Implementation: chapters on Image Pre-Processing; Ground Data Collection; Integration with GIS; Quantitative Models in Remote Sensing; Validation and accuracy assessment; • Remote Sensing Analysis - Applications: LITHOSPHERIC SCIENCES: chapters on Topography; Geology; Soils; PLANT SCIENCES: Vegetation; Agriculture; HYDROSPHERIC and CRYOSPHERIC SCIENCES: Hydrosphere: Fresh and Ocean Water; Cryosphere; GLOBAL CHANGE AND HUMAN ENVIRONMENTS: Earth Systems; Human Environments & Links to the Social Sciences; Real Time Monitoring Systems and Disaster Management; Land Cover Change Illustrated throughout, an essential resource for the analysis of remotely sensed

data, the SAGE Handbook of Remote Sensing provides researchers with a definitive statement of the core concepts and methodologies in the discipline.

Research and Techniques for Visualizing Benthic Environments

Principles, Interpretation, and Applications, Fourth Edition

Remote Sensing Handbook - Three Volume Set

Real-Time Progressive Hyperspectral Image Processing

Hyperspectral Indices and Image Classifications for Agriculture and Vegetation

The SAGE Handbook of Remote Sensing

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*A PRACTICAL, FULL-COLOR GUIDE TO REMOTE SENSING* Written by an internationally renowned expert in the field, *An Introduction to Contemporary Remote Sensing* introduces the latest developments in remote sensing and imaging science. This book covers basic principles and discusses essential technologies, such as aerial photography, radar, Lidar (light detection and ranging), photogrammetry, satellites, thermal radiation, and much more. Full-color images illustrate the concepts presented, and review questions at the end of each chapter help reinforce learning. This detailed resource provides the solid foundation in remote sensing required for developing diverse geospatial applications. Coverage includes: Geographic information system (GIS) Global positioning system (GPS), mobile mapping, and Google Earth Electromagnetic radiation principles Characteristics of remotely sensed data Spatial, spectral, radiometric, and temporal resolution Aerial photo interpretation Photogrammetry Remote sensors Earth observation satellites Digital image analysis Thermal remote sensing Active remote sensing This book explores the applicability of multiple remote sensors to acquire information relevant to restoration and conservation efforts in wetlands using data collected from airborne and space multispectral/hyperspectral sensors, light detection and ranging (LiDAR), Unmanned Aircraft Systems (UAS), and a hand-held spectroradiometer. This book also examines digital data processing techniques such as object-based image analysis, machine learning, texture analysis, and data fusion. After an introduction to the Everglades and to remote sensing, the book is divided into

four parts based on the sensor systems used. There are chapters on vegetation mapping, biomass and water quality modeling, applications of hyperspectral data for plant stress analysis and coral reef mapping, studies of airborne LiDAR data for coastal vulnerability analysis and DEM improvement, as well as chapters that explore a fusion of multiple sensors for different datasets. Features Introduces concepts, theories, and advanced processing techniques A complete introduction of machine learning, object-based image analysis, data fusion, and ensemble analysis techniques in processing data from multiple remote sensors Explains how multiple remote sensing systems are applied in the wetland ecosystems of Florida The author had been teaching and using both systems and her research is widely recognized Multi-sensor System Applications in the Everglades Ecosystems provides a comprehensive application of remote sensing techniques in the Florida Everglades and its coastal ecosystems. It will prove an invaluable resource for the restoration and conservation of the Florida Everglades and beyond, for global wetlands in general. Any professional, scientist, engineer, or student working with remote sensing and wetland ecosystems will reap enormous benefits from this book.

Based on the authors' research, this book introduces the main processing techniques in hyperspectral imaging. In this context, SVM-based classification, distance comparison-based endmember extraction, SVM-based spectral unmixing, spatial attraction model-based sub-pixel mapping and MAP/POCS-based super-resolution reconstruction are discussed in depth. Readers will gain a comprehensive understanding of these cutting-edge hyperspectral imaging techniques. Researchers and graduate students in fields such as remote sensing, surveying and mapping, geosciences and information systems will benefit from this valuable resource.

Concepts, Methodologies, Tools, and Applications

Hyperspectral Remote Sensing

Spatial Big Data Science

Hyperspectral Image Fusion

Multi-sensor System Applications in the Everglades Ecosystem

Fundamentals and Practices

**This book is geared for advanced level research in the general**

**subject area of remote sensing and modeling as they apply to the coastal marine environment. The various chapters focus on the latest scientific and technical advances in the service of better understanding coastal marine environments for their care, conservation and management. Chapters specifically deal with advances in remote sensing coastal classifications, environmental monitoring, digital ocean technological advances, geophysical methods, geoacoustics, X-band radar, risk assessment models, GIS applications, real-time modeling systems, and spatial modeling. Readers will find this book useful because it summarizes applications of new research methods in one of the world's most dynamic and complicated environments. Chapters in this book will be of interest to specialists in the coastal marine environment who deals with aspects of environmental monitoring and assessment via remote sensing techniques and numerical modeling.**

**This book explores the environmental, economic, and socio-political dynamics of sustainability from a geographic perspective. The chapters unite the often disparate worlds of environment, economics, and politics by seeking to understand and visualize a range of sustainability practices on the ground and in place. In concert, the book provides an overview of a range of geotechnical applications associated with environmental change (water resources, land use & land cover change); as well as investigates more nuanced and novel examples of local economic development in cities. The diverse collection maps local practices from urban farming to evolving and thriving industries such as metal scrapping and craft beer. Additionally, the book provides an integrated geotechnical framework for understanding and assessing ecosystem services, explores the deployment of unmanned systems to understand urban environmental change, interrogates the spatial politics of urban green movements, examines the implications of revised planning practices, and investigates environmental justice. The book will be of interest to researchers, students, and anyone seeking to better understand sustainability at multiple scales in urban environments.**

**This book brings together a collection of invited interdisciplinary perspectives on the recent topic of Object-based Image Analysis (OBIA). Its content is based on select papers from the 1 OBIA International Conference held in Salzburg in July 2006, and is enriched by several invited chapters. All submissions have passed through a blind peer-review process resulting in what we believe is a timely volume of the highest scientific, theoretical and technical standards. The concept of OBIA first gained widespread interest within the GIScience (Geographic Information Science) community circa 2000, with the advent of the first commercial software for what was then termed 'object-oriented image analysis'. However, it**

***is widely agreed that OBIA builds on older segmentation, edge-detection and classification concepts that have been used in remote sensing image analysis for several decades. Nevertheless, its emergence has provided a new critical bridge to spatial concepts applied in multiscale landscape analysis, Geographic Information Systems (GIS) and the synergy between image-objects and their radiometric characteristics and analyses in Earth Observation data (EO).***

***Revised and enlarged to reflect new developments in the field, the fourth edition of this well-established text provides an introduction to quantitative evaluation of satellite- and aircraft-derived remotely retrieved data. Each chapter covers the pros and cons of digital remotely sensed data, without detailed mathematical treatment of computer based algorithms, but in a manner conducive to an understanding of their capabilities and limitations.***

***Hyperspectral Data Processing***

***Unmanned Aerial Vehicle: Applications in Agriculture and Environment***

***Hyperspectral Image Processing***

***Further Developments in the Theory and Practice of Cybercartography***

***Fundamentals of Capturing and Processing Drone Imagery and Data Seafloor Mapping along Continental Shelves***

This two volume set (LNCS 8156 and 8157) constitutes the refereed proceedings of the 17th International Conference on Image Analysis and Processing, ICIAP 2013, held in Naples, Italy, in September 2013. The 162 papers presented were carefully reviewed and selected from 354 submissions. The papers aim at highlighting the connection and synergies of image processing and analysis with pattern recognition and machine learning, human computer systems, biomedical imaging and applications, multimedia interaction and processing, 3D computer vision, and understanding objects and scene.

Image Analysis, Classification and Change Detection in Remote Sensing: With Algorithms for Python, Fourth Edition, is focused on the development and implementation of statistically motivated, data-driven techniques for digital image analysis of remotely sensed imagery and it features a tight interweaving of statistical and machine learning theory of algorithms with computer codes. It develops statistical methods for the analysis of optical/infrared and synthetic aperture radar (SAR) imagery, including wavelet transformations, kernel methods for nonlinear classification, as well as an introduction to deep learning in the context of feed forward neural networks. New in the Fourth Edition: An in-depth treatment of a recent sequential change detection algorithm for polarimetric SAR image time series. The accompanying software consists of Python (open source) versions of all of the main image analysis algorithms. Presents easy, platform-independent software installation methods (Docker containerization). Utilizes freely accessible imagery via the Google Earth Engine and provides many examples of cloud programming (Google Earth Engine API). Examines deep learning examples including TensorFlow and a sound introduction to neural networks, Based on the success and the reputation of the previous editions and compared to other textbooks in the market, Professor Canty's fourth edition differs in the depth and sophistication of the material treated as well as in its consistent use of computer codes to illustrate the methods and algorithms discussed. It is self-contained and illustrated with many programming examples, all of which can be conveniently run

in a web browser. Each chapter concludes with exercises complementing or extending the material in the text.

A volume in the three-volume Remote Sensing Handbook series, Remote Sensing of Water Resources, Disasters, and Urban Studies documents the scientific and methodological advances that have taken place during the last 50 years. The other two volumes in the series are Remotely Sensed Data Characterization, Classification, and Accuracies, and Land Reso

Emerging Spatial Big Data (SBD) has transformative potential in solving many grand societal challenges such as water resource management, food security, disaster response, and transportation. However, significant computational challenges exist in analyzing SBD due to the unique spatial characteristics including spatial autocorrelation, anisotropy, heterogeneity, multiple scales and resolutions which is illustrated in this book. This book also discusses current techniques for, spatial big data science with a particular focus on classification techniques for earth observation imagery big data. Specifically, the authors introduce several recent spatial classification techniques, such as spatial decision trees and spatial ensemble learning. Several potential future research directions are also discussed. This book targets an interdisciplinary audience including computer scientists, practitioners and researchers working in the field of data mining, big data, as well as domain scientists working in earth science (e.g., hydrology, disaster), public safety and public health. Advanced level students in computer science will also find this book useful as a reference.

Remote Sensing and Modeling

Algorithm Architecture and Implementation

Spatial Concepts for Knowledge-Driven Remote Sensing Applications

An Introduction

Techniques for Spectral Detection and Classification

Remote Sensing of Urban and Suburban Areas

Demand for minimally processed foods has resulted in the development of innovative, non-thermal food preservation methods, such as high-pressure sonication, ozone, and UV treatment. This book presents a summary of these novel food processing techniques. It also covers new methods used to monitor microbial activity, including spectroscopic methods (FT-IR and Raman), molecular and electronic noses, and DNA-based methods.

For junior/graduate-level courses in Remote Sensing in Geography, Geology, Forestry, and Biology. This revision of Introductory Digital Image Processing: A Remote Sensing Perspective continues to focus on digital image processing of aircraft- and satellite-derived, remotely sensed data for Earth resource management applications. Extensively illustrated, it explains how to extract biophysical information from remote sensor data for almost all multidisciplinary land-based environmental projects. Part of the Prentice Hall Series Geographic Information Science.

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

Remote sensing has undergone profound changes over the past two decades as GPS, GIS, and sensor advances have significantly expanded the user community and availability of images. New tools, such as

automation, cloud-based services, drones, and artificial intelligence, continue to expand and enhance the discipline. Along with comprehensive coverage and clarity, Sabins and Ellis establish a solid foundation for the insightful use of remote sensing with an emphasis on principles and a focus on sensor technology and image acquisition. The Fourth Edition presents a valuable discussion of the growing and permeating use of technologies such as drones and manned aircraft imaging, DEMs, and lidar. The authors explain the scientific and societal impacts of remote sensing, review digital image processing and GIS, provide case histories from areas around the globe, and describe practical applications of remote sensing to the environment, renewable and nonrenewable resources, land use/land cover, natural hazards, and climate change.

- Remote Sensing Digital Database includes 27 examples of satellite and airborne imagery that can be used to jumpstart labs and class projects. The database includes descriptions, georeferenced images, DEMs, maps, and metadata. Users can display, process, and interpret images with open-source and commercial image processing and GIS software.
- Flexible, revealing, and instructive, the Digital Image Processing Lab Manual provides 12 step-by-step exercises on the following topics: an introduction to ENVI, Landsat multispectral processing, image processing, band ratios and principal components, georeferencing, DEMs and lidar, IHS and image sharpening, unsupervised classification, supervised classification, hyperspectral, and change detection and radar.
- Introductory and instructional videos describe and guide users on ways to access and utilize the Remote Sensing Digital Database and the Digital Image Processing Lab Manual.
- Answer Keys are available for instructors for questions in the text as well as the Digital Image Processing Lab Manual.

Polarized Light

Advances in Signal Processing and Exploitation Techniques

Remote Sensing

Augmented Vision Perception in Infrared

Land Resources Monitoring, Modeling, and Mapping with Remote Sensing

Novel Food Preservation and Microbial Assessment Techniques

Environmental information and systems play a major role in environmental decision making. As such, it is vital to understand the impact that they have on different aspects of sustainable environmental management, as well as to understand the opportunism they might present for further improvement. *Environmental Information Systems: Concepts, Methodologies, Tools, and Applications* is an innovative reference source containing the latest research on the use of information systems to track and organize environmental data for use in an overall environmental management system. Highlighting a range of topics such as environmental analysis, remote sensing, and geographic information science, this multi-volume book is designed for engineers, data scientists, practitioners, academicians, and researchers interested in all aspects of environmental information systems.

*Hyperspectral Image Fusion* is the first text dedicated to the fusion

techniques for such a huge volume of data consisting of a very large number of images. This monograph brings out recent advances in the research in the area of visualization of hyperspectral data. It provides a set of pixel-based fusion techniques, each of which is based on a different framework and has its own advantages and disadvantages. The techniques are presented with complete details so that practitioners can easily implement them. It is also demonstrated how one can select only a few specific bands to speed up the process of fusion by exploiting spatial correlation within successive bands of the hyperspectral data. While the techniques for fusion of hyperspectral images are being developed, it is also important to establish a framework for objective assessment of such techniques. This monograph has a dedicated chapter describing various fusion performance measures that are applicable to hyperspectral image fusion. This monograph also presents a notion of consistency of a fusion technique which can be used to verify the suitability and applicability of a technique for fusion of a very large number of images. This book will be a highly useful resource to the students, researchers, academicians and practitioners in the specific area of hyperspectral image fusion, as well as generic image fusion.

Advanced imaging spectral technology and hyperspectral analysis techniques for multiple applications are the key features of the book. This book will present in one volume complete solutions from concepts, fundamentals, and methods of acquisition of hyperspectral data to analyses and applications of the data in a very coherent manner. It will help readers to fully understand basic theories of HRS, how to utilize various field spectrometers and bioinstruments, the importance of radiometric correction and atmospheric correction, the use of analysis, tools and software, and determine what to do with HRS technology and data.

This book explores recursive architectures in designing progressive hyperspectral imaging algorithms. In particular, it makes progressive imaging algorithms recursive by introducing the concept of Kalman filtering in algorithm design so that hyperspectral imagery can be processed not only progressively sample by sample or band by band but also recursively via recursive equations. This book can be considered a companion book of author's books, Real-Time Progressive Hyperspectral Image Processing, published by Springer in 2016.

Image Analysis, Classification and Change Detection in Remote Sensing  
Advances in Coastal and Marine Resources

Algorithm Design and Analysis

With Algorithms for Python, Fourth Edition

Object-Based Image Analysis

*The book covers the most crucial parts of real-time hyperspectral image processing: causality and real-time capability. Recently, two new concepts of real time hyperspectral image processing, Progressive HyperSpectral Imaging (PHSI) and Recursive HyperSpectral Imaging (RHSI). Both of these can be used to design algorithms and also form an integral part of real time hyperpsectral image processing. This book focuses on progressive nature in algorithms on their real-time*

*and causal processing implementation in two major applications, endmember finding and anomaly detection, both of which are fundamental tasks in hyperspectral imaging but generally not encountered in multispectral imaging. This book is written to particularly address PHSI in real time processing, while a book, Recursive Hyperspectral Sample and Band Processing: Algorithm Architecture and Implementation (Springer 2016) can be considered as its companion book.*

*A volume in the three-volume Remote Sensing Handbook series, Land Resources Monitoring, Modeling, and Mapping with Remote Sensing documents the scientific and methodological advances that have taken place during the last 50 years. The other two volumes in the series are Remotely Sensed Data Characterization, Classification, and Accuracies, and Remo*

*This book showcases how new and emerging technologies like Unmanned Aerial Vehicles (UAVs) are trying to provide solutions to unresolved socio-economic and environmental problems. Unmanned vehicles can be classified into five different types according to their operation. These five types are unmanned ground vehicles, unmanned aerial vehicles, unmanned surface vehicles (operating on the surface of the water), unmanned underwater vehicles, and unmanned spacecraft. Unmanned vehicles can be guided remotely or function as autonomous vehicles. The technology has a wide range of uses including agriculture, industry, transport, communication, surveillance and environment applications. UAVs are widely used in precision agriculture; from monitoring the crops to crop damage assessment. This book explains the different methods in which they are used, providing step-by-step image processing and sample data. It also discusses how smart UAVs will provide unique opportunities for manufacturers to utilise new technological trends to overcome the current challenges of UAV applications. The book will be of great interest to researchers engaged in forest carbon measurement, road patrolling, plantation monitoring, crop yield estimation, crop damage assessment, terrain modelling, fertilizer control, and pest control.*

*Algorithms for Multispectral and Hyperspectral Imagery  
Optical Remote Sensing*

*Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data*