

# Preface

Earth observation is currently a critical issue of worldwide interest. It is used to map the Earth, monitor the environment, manage our limited resources, and predict, record, and respond to global change and disasters. All space programs around the world have a significant component of Earth observation to accomplish the above objectives. For such scientific explorations, geospatial technology plays a core and fundamental role throughout the entire data acquisition, processing, interpretation, and information extraction process. This rapid progression has driven geospatial technology into a transition period. On one hand, sensing technology provides abundant data with increasingly higher radiometric, spatial, spectral, and temporal resolutions. On the other hand, in terms of data processing and interpretation techniques, various new developments are being introduced to geospatial technology from a number of related disciplines, including machine vision, pattern recognition, computational science, and applied mathematics. Driven by such new developments, the solutions to classical mapping-related tasks are moving towards higher level automation and resolution. In the meantime, a new, non-classical task is consequently emerging, which is meant to serve the public and decision-makers with all types of geospatial products, including data, information, and knowledge.

The book covers a wide range of topics in Earth observation, which can be grouped into seven parts with a total of 19 chapters.

Part I pertains to system, platform, sensor and sensor integration. The discussion varies from space system (Chapter 1, Li), to aerial platform, in particular UAV (Chapter 2, Yan *et al.*) and mobile vehicles (Chapter 3, Li *et al.*), all of which utilize integrated sensors for Earth observation data collection at a different scale for a variety of applications, such as large scale topographic mapping and road surface evaluation. Chapter 1 also presents an overview on geospatial information service as an extension to the conventional Earth observation tasks.

Part II, consisting of Chapter 4 (Crespi *et al.*) and Chapter 5 (Yuan), deals with the geometric aspects of data processing in Earth observation. Both chapters discuss the principles of the physical model and the generalized or replace model, with the former more focused on satellite images while the latter is focused on both aerial and satellite images. Both chapters provide empirical examples with evaluation and comparison of the two types of models. Moreover, Chapter 4 provides numerical solutions to assure reliable results in sensor orientation.

Part III concentrates on some physical aspects of remote sensing. Chapter 6 (Liang *et al.*) presents algorithms for mapping all types of land surface radiative fluxes from MODIS data. The developed algorithms are evaluated by using well-distributed global measurements over various land cover types at different elevations. Such a study is useful in driving high-resolution land ecosystem/carbon cycle and hydrological models. Chapter 7 (Gens) starts with a concise overview on surface reflective and emissive properties, electromagnetic spectrum, energy-matter interaction, and passive and active remote sensing. It then presents a wide

range of vivid applications of remote sensing techniques, including urban areas, vegetation, biodiversity and coral reefs, geology and soils, water bodies, and cryosphere, some of which are further detailed in subsequent chapters.

Part IV focuses on algorithms for remote sensing image classification and analysis. Chapter 8 (Waske *et al.*) is a review of classification methods, varying from classical and advanced individual classifiers to their combined use (multi classifiers). Such methods are used for the classification of SAR, multispectral, and hyperspectral images. The classification of multiple data sources such as optical images and LiDAR are also presented. Chapter 9 (Zhang and Zhong) discusses topics related to hyperspectral image analysis: feature selection, clustering (unsupervised classification), and spectral unmixing. After a concise review of popular methods, the authors present a framework based on artificial immune systems as an alternative solution: the clonal selection approach is used for feature selection, while an artificial immune classifier is developed for hyperspectral images. The unmixing problem is formulated as a kernel-based least squares estimation. Chapter 10 (Han *et al.*) addresses the effect of resolution on image classification. Versions of Landsat TM and SPOT images under different aggregation rates are used for analysis and evaluation.

Part V is composed of Chapters 11 and 12. The former (Chapter 11, Trinder and Sowmya) discusses automated feature extraction in photogrammetry from the machine learning point of view. A prototype tool is discussed and evaluated for road network extraction from remote sensing images. As for building extraction, the chapter presents a solution based on level set segmentation and Dempster-Shafer fusion of multiple data sources. Chapter 12 (Lisini *et al.*) presents a framework for image-based feature extraction for geospatial analysis. Results of road and building extraction from SAR, LiDAR, and optical images are presented; and such a framework is also used for automated SAR image registration and change detection as an alternative approach to the pixel-based method.

Part VI extends the content of the book to web-based geospatial service. Chapter 13 (Gong *et al.*) outlines the concepts and details the contents, concerns, standards, technologies, and design of a geospatial service web, a prototype for which is reported. Chapter 14 (Zhu *et al.*) discusses the selection and optimization of web services in terms of response time. The developed algorithm is able to deal with uncertainty in service response time, which makes the remotely sensed image processing service chain more reliable.

Part VII consists of five chapters that primarily demonstrate various applications of the geospatial technology. Chapter 15 (Konecny) reports the challenges and start-of-the-art of cadastral mapping using integrated Earth observation techniques, ranging from satellite, aerial, and terrestrial surveying to documentation using amateur handled cameras and GIS. Chapter 16 (Zhou) seeks an efficient and practical method to determine the spatio-temporal pattern of environmental change caused by land cover change by integrating multi-temporal and multi-scale remotely sensed data from various sources. It quantifies spatial pattern for analyzing land cover changes through calculating the class-level landscape metrics of change trajectories. Water remote sensing is discussed in Chapter 17 (Chen and Yu). Starting with the effects of water body on electromagnetic radiation and its

optical properties, this chapter discusses *in situ* and remote sensing measurements and atmospheric correction methods to acquire reliable and precise measurements. A variety of applications are also addressed, including oil spill detection, water depth, water temperature, and total suspended sediment concentration, colored dissolved organic matter concentration, chlorophyll-a concentration, primary productivity estimation, and red tide detection. Case studies are presented to demonstrate the performance of atmospheric correction and coastal water environment management. Chapter 18 (Shan *et al.*) reviews the status of flood mapping in the USA and reports a case study in the state of Indiana. Temporal Landsat TM images are used to determine flood extent, while damages are estimated by jointly using crop and road GIS layers. A web-mapping service is used for public access and information dissemination. Chapter 19 (Zhang *et al.*) presents an overview of the role of Earth observation technology in the establishment of e-government and decision-making in China. The applications of such technology and developed systems in the recent Wenchuan earthquake (May 2008, China) are highlighted through slide identification, hazards assessment, and loss estimation. In addition, three intensive prototype systems and their associate studies are reported: the Flood Disaster Monitoring and Evaluation System for managing the recent floods and their mitigation; the Water Resources and Desertification Monitoring Analysis System, which provides related information services for the management and decision-making of government; the West Development Information Service System that provides important social and economic development and resource information for governments.

As reflected from the above summary, geospatial technology has played multiple roles in Earth observation, ranging from data acquisition, processing, analysis, information extraction, service, and decision-making. It became a key and indispensable core component in Earth observation for sciences, economics, and homeland security. It is unrealistic for one book of this size to cover all aspects of this technology, however, we attempted to select and organize the materials in such a way that the essential, fundamental methods and recent, promising developments in this and other related disciplines are covered. We also attempted to promote geospatial technology by including representative and influential applications and case studies that have broad impact.

The book is primarily targeted to graduate students and professionals. It can be used as a reference to augment courses in remote sensing, geographic information systems, photogrammetry, and natural resources management. The resources provided in the book, such as reference to literatures, free and shareware, data vendors or sources, and case studies are useful for both researchers and practitioners as well as administrators. We also expect the book to be introductory material to more advanced topics and future developments and applications. Finally, we welcome corrections, comments, and suggestions that would benefit the audience and improve our future endeavors.

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