Preface

One of the key milestones of radar remote sensing for civil applications was the launch of the European Remote Sensing Satellite 1 (ERS 1) in 1991. The platform carried a variety of sensors; the Synthetic Aperture Radar (SAR) is widely considered to be the most important. This active sensing technique provides all-day and all-weather mapping capability of considerably fine spatial resolution. ERS 1 and its sister system ERS 2 (launch 1995) were primarily designed for ocean applications, but soon the focus of attention turned to onshore mapping. Examples for typical applications are land cover classification also in tropical zones and monitoring of glaciers or urban growth. In parallel, international Space Shuttle Missions dedicated to radar remote sensing were conducted starting already in the 1980s. The most prominent were the SIR-C/X-SAR mission focussing on the investigation of multi-frequency and multi-polarization SAR data and the famous Shuttle Radar Topography Mission (SRTM). Data acquired during the latter enabled to derive a DEM of almost global coverage by means of SAR Interferometry. It is indispensable even today and for many regions the best elevation model available. Differential SAR Interferometry based on time series of imagery of the ERS satellites and their successor Envisat became an important and unique technique for surface deformation monitoring.

The spatial resolution of those devices is in the order of some tens of meters. Image interpretation from such data is usually restricted to radiometric properties, which limits the characterization of urban scenes to rather general categories, for example, the discrimination of suburban areas from city cores. The advent of a new sensor generation changed this situation fundamentally. Systems like TerraSAR-X (Germany) and COSMO-SkyMed (Italy) achieve geometric resolution of about 1 m. In addition, these sophisticated systems are more agile and provide several modes tailored for specific tasks. This offers the opportunity to extend the analysis to individual urban objects and their geometrical set-up, for instance, infrastructure elements like roads and bridges, as well as buildings. In this book, potentials and limits of SAR for urban mapping are described, including SAR Polarimetry and SAR Interferometry. Applications addressed comprise rapid mapping in case of time critical events, road detection, traffic monitoring, fusion, building reconstruction, SAR image simulation, and deformation monitoring.

Audience

This book is intended to provide a comprehensive overview of the state-of-the art of urban mapping and monitoring by modern satellite and airborne SAR sensors. The reader is assumed to have a background in geosciences or engineering and to be familiar with remote sensing concepts. Basics of SAR and an overview of different techniques and applications are given in Chapter 1. All chapters following thereafter focus on certain applications, which are presented in great detail by well known experts in these fields.

In case of natural disaster or political crisis rapid mapping is a key issue (Chapter 2). An approach for automated extraction of roads and entire road networks is presented in Chapter 3. A topic closely related to road extraction is traffic monitoring. In case of SAR, Along-Track Interferometry is a promising technique for this task, which is discussed in Chapter 4. Reflections at surface boundaries may alter the polarization plane of the signal. In Chapter 5, this effect is exploited for object recognition from a set of SAR images of different polarization states at transmit and receive. Often, up-to-date SAR data has to be compared with archived imagery of complementing spectral domains. A method for fusion of SAR and optical images aiming at classification of settlements is described in Chapter 6. The opportunity to determine the object height above ground from SAR Interferometry is of course attractive for building recognition. Approaches designed for mono-aspect and multi-aspect SAR data are proposed in Chapters 7 and 8, respectively. Such methods may benefit from image simulation techniques that are also useful for education. In Chapter 9, a methodology optimized for real-time requirements is presented. Monitoring of surface deformation suffers from temporal signal decorrelation especially in vegetated areas. However, in cities many temporally persistent scattering objects are present, which allow tracking of deformation processes even for periods of several years. This technique is discussed in Chapter 10. Finally, in Chapter 11, design constraints of a modern airborne SAR sensor are discussed for the case of an existing device together with examples of high-quality imagery that state-of-the-art systems can provide.

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