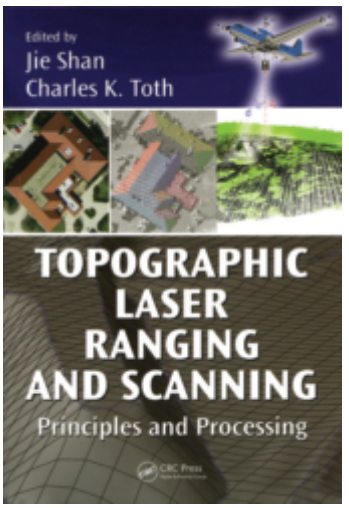
Book Review



Topographic Laser Ranging and Scanning: Principles and Processing

Ji Shan and Charles K. Toth (Eds.)

CRC Press: Boca Raton, FL. 2009. xvii and 590 pp., diagrams, maps, photos, images, index

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Topographic Laser Ranging and Scanning: Principles and Processing targets a multidisciplinary environmental research audience with a detailed discussion of topographic lidar, including its history, technology, calibration, quality, and management as well as a variety of techniques for lidar-assisted information extraction. This book is organized into 19 chapters, with 29 contributors from academic, commercial, and governmental organizations in the United States, Finland, Canada, Germany, Australia, Austria, China, France, and the United Kingdom. A significant number of grayscale figures, tables, and equations are complemented by chapter-level references, 12 color figures, an index, and a key to abbreviations. The 19 chapters are logically organized into four parts.

The first and smallest part of the book introduces lasers, laser ranging, profiling, and scanning principles, and provides detailed descriptions of actual airborne, spaceborne, and terrestrial lidar systems implemented through the end of 2007. This is the material for the widest possible subset of the intended lidar audience. Diagrams and equations are used to help explain things like timed pulse versus phase comparison methods in laser ranging, lidar beam divergence and reflectivity, and lidar safety. The descriptions of real-world lidar systems transition from people-oriented historical reviews toward more complex lidar equipment specifications.

The second part discusses lidar system calibration, pulsed lidar techniques and their impact on topographic mapping, direct georeferencing equations in the context of lidar system-wide design and integration, and the process of analyzing the waveforms returned in small-footprint lidar, including the extraction of attributes such as range, pulse width, and intensity. This section helps readers understand the operational characteristics of the different real-world lidar systems previously introduced. The processes of developing digital elevation models (DEMs) as well as models of forest canopy structure are also introduced here as a precursor to various sections in the latter parts of the book.

The third part explains lidar strip adjustment concepts and techniques to minimize or eliminate between-strip discrepancies within the final corrected point cloud, lidar error budgeting and quality control both internal and external to the data itself, and very practical questions of lidar data management. This section has more practical information for those actually processing lidar data. For example, lidar quality control is illustrated using a short case study, and the chapter devoted to data management provides practical details on raster, vector, ASCII, the LAS standard format, processing conventions, and the use of spatial databases. Specific and practical advice is given, such as the recommendation to use files rather than spatial databases in high throughput production operations.

The fourth and largest part gives a detailed presentation of lidar-assisted information extraction, including data filtering techniques to extract bare earth DEMs, how to assess DEM quality, the use of lidar for forest inventory, lidar and photogrammetric integration, and lidar-assisted extraction of urban features and in particular 3D building attributes. In the forest inventory chapter, an organized presentation of history, forest information requirements, forest-laser physics, as well as extraction of biophysical variables and change detection is found. A subsequent chapter describes the dependence of lidar and photogrammetric integration on multisensor triangulation and orthorectification. This sets the stage, using an IKONOS and lidar case study, for solid geometric correction required for more complex extraction of 3D building attributes. Algorithms for autonomously extracting planar roof segments are given in these chapters. A highlight in the last chapter is an "apples-to-apples" empirical comparison of lidar-assisted 3D building reconstructions demonstrated by 10 participants.

The book is very impressive. It is the most comprehensive and up-to-date treatment of quantitative lidar principles, from lasers to terrestrial to airborne lidar deployment, and is an excellent baseline for those researching the technology beyond the end of 2007. The theoretical presentation of lidar is both systematic and detailed such that it is an important contribution to other lidar applications not discussed. Its greatest strength in terms of synoptic presentation of lidar-assisted information extraction applications is clearly in urban feature reconstruction, with lesser but high quality emphasis on forest inventory. The book's final example of an empirical comparison across, not just two or three, but 10 3D building reconstruction methods is valuable.

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The book's quantitative approach to lidar ensures that things like error budgets, geometric correction, and challenges in multisensor integration are taken more seriously in the lidar community. The book does not seem to be intended for cover-to-cover light reading – some overlap in background material between chapters allows the reader to focus on the most relevant chapters of interest. While selected chapters will engage the wider lidar audience, readers should have good quantitative skills to best access the expertise of the book's contributors. Some equation variables could be more consistently defined to allow easier "reverse engineering" such as in an equation describing return laser power. A few figure components, such as forest structure images in a color plate, could be enlarged for easier interpretation, and some acronyms such as lidar versus ALS could be more consistently presented between chapters. Inconsistencies between contributors are usually clarified in the text (reflecting well on the editors), and, if taken with a grain of salt, the diverse expertise behind these variations can help make the broader lidar literature more accessible.