Airborne and Terrestrial Laser Scanning

Last month we reported back from the Intergeo trade show that it was all about three abbreviations: Airborne Laser Scanning (ALS), Terrestrial Laser Scanning (TLS) and Mobile Laser Scanning (MLS). This month a comprehensive text book, Airborne and Terrestrial Laser Scanning, appears from Whittles Publishing, aimed at students, researchers and practitioners. In just two decades all three scanning techniques have become well established survey techniques for acquiring (geo)spatial information. Yet publicly accessible knowledge about them has been broadly distributed over the literature. This concise book redresses the balance.

Airborne and terrestrial laser scanning differ in terms of data capture mode, typical project size, scanning mechanism and obtainable accuracy and resolution, yet share many features, especially those resulting from the laser-ranging technology. Particularly when it comes to point-cloud processing, the same algorithms are often applied to both ALS and TLS data. The book therefore attempts an integrated treatment of ALS and TLS technology and processing, starting with an introduction to ALS and TLS technology covering range-measurement principles, scanning mechanisms, GPS/IMU integration, full waveform digitisation, error budgeting and operational aspects of laser-scan survey. The focus is on principles rather than technical specifications, the latter being rapidly outdated as technology advances (latest technical specifications are found in *GIM International* product overviews).

Common to all laser-scanning projects are the need to visualise and structure acquired 3D point-clouds, and proper geo-referencing of data. Visualisation techniques for both original point-cloud and raster data are discussed; this being an important tool in quality assessment. Also presented are point-cloud data structures and segmentation algorithms for extracting further information from them. The registration of multiple datasets and calibration of airborne and terrestrial laser scanners is also dealt with. Elaborated are mathematical models showing the relationship between laser-scanner observations and resulting coordinates of reflecting surface points. Based on these models, typical instrument design sources of error are discussed. Point-cloud registration is the transformation of a dataset into an externally defined coordinate system; coordinate systems and methods are elaborated.

The section dealing with applications starts with extraction of digital terrain models (DTM) from airborne laser-scanning data. High-quality DTM production has been the major driving force behind airborne laser scanner development. Compared to other survey technologies, ALS enables DTMs of higher quality at lower cost; turning it within a few years of introduction into the preferred technology. Point-clouds from ALS survey contain points not only on terrain, but also vegetation, buildings and other objects. While these are useful in many applications, non-ground points must be removed from point-clouds for DTM production. The most popular strategies and algorithms for this so-called ‘filtering' process are reviewed.

The density of current ALS point-clouds is high enough for the retrieval of detailed information on buildings and trees. Building detection makes use of separation between ground and non-ground points by filtering algorithms, but needs to further classify non-ground points. Building detection is followed by a review of algorithms for deriving their 2D outlines, used to update traditional 2D building maps or as intermediate step for complete 3D building reconstruction. The capability of ALS to obtain both ground and vegetation points led to rapid application in forest inventory studies, forest management, carbon-sink analysis, bio-diversity characterisation and habitat analysis.

The last three book chapters present applications mainly based on TLS. In industry, 3D CAD models of installations are required for maintenance management, safety analysis and revamping. Change detection and deformation analysis play an important role in civil and geotechnical engineering applications. TLS has proven value in projects such as monitoring dams, tunnels and areas susceptible to land erosion or landslide, whereas ALS represents an efficient tool for monitoring power lines and water embankments. Applications of laser scanning in the documentation of cultural heritage (as described in last month's cover story) are discussed in several case-studies. The ability of terrestrial laser scanners to rapidly capture complex surfaces of historical buildings and sculptures makes it a preferred technology in cultural heritage and in archaeological studies.

The book finishes with the missing abbreviation MLS, providing a review of vehicle-borne mobile-mapping systems. Discussed are various modes of observation (stop-and-go, on-the-fly), design considerations, and data-processing flows. Present-day systems are shown together with their application in corridor mapping of road and railway environments.

Airborne and Terrestrial Laser Scanning, by Professor George Vosselman and Professor Hans-Gerd Maas, Whittles Publishing. ISBN 978-

1904445-87-6, 240 × 170mm, 320pp, liberally illustrated hardback, full colour throughout. Price: £80.

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