Accuracy of 3D Building Models Created Using Terrestrial and Airborne Laser Scanning Data

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SUMMARY

There is a growing interest in building modelling, especially from laser scanning data; 3D models are used in many professional applications, such as urban planning, spatial analysis, inventories of historical and cultural heritage, promotion of tourist places, and Building Information Modelling (BIM). This work presents the accuracy assessment of 3D building models created from combined airborne and terrestrial laser scanning data. The investigation was performed on both heritage and residential building models created from LiDAR point clouds acquired using terrestrial Leica ScanStation 2 and airborne Riegl LMS-Q680i scanners. Terrestrial Laser Scanning (TLS) data obtained with average point spacing of about two centimetres was the primary data used in modelling. For the modelling of building elements that were invisible from ground stations, e.g. roofs, airborne Laser Scanning (ALS) data was used; it was collected with a density of about 12 pts./m2. Stitching of TLS and ALS was simplified by transforming both into the same coordinate system. Finally, textures mapping was applied, whereby textures were created from digital images taken with a camera Canon 40D. Modelling was performed semi-automatically using both the commercial software Leica Cyclone, as well as the author's software. While the accuracy of models is affected by many factors, such as scanning data accuracy, TLS and ALS data integration errors, model generalization or textures errors, it is challenging to discover the impact of all these parameters separately. The authors decided to assess the accuracy of 3D models considering the influence of all these factors simultaneously. The accuracy of models was assessed by comparing the coordinates of characteristic points of the models and the corresponding coordinates of these points measured on the real buildings, obtained by using total station Leica TCR407Power. The field-measured points were treated as error-free reference points. In addition to determining the cumulative accuracy of the model estimated in the range between 10 to 14 centimetres depending on the model, the authors attempted to investigate the single impact of several factors such as quality of point cloud registration, matching of TLS and ALS data, intrinsic laser data properties. Some of these factors reveal the features of systematic errors, thus their influence on the accuracy of final 3D models can be removed. In particular, improvement of the model's quality was gained applying the Iterative Closest Point (ICP) algorithm, resulting in better point clouds registration between TLS and ALS data. In this case, a reduction of modelling errors up to a few centimetres was observed.