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Automated Assessment of Digital Terrain Models Derived From Airborne Laser Scanning

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In our previous research we have quantified different error sources contributing to the accuracy of a single laser point coordinate and implemented an error propagation algorithm that estimates the expected accuracy per each target (Schaer et al., 2007). We have also suggested a unique quality-metric that considers all uncertainties induced by direct georeferencing and the constantly evolving scanning geometry. Later, we have proposed a novel methodology that derives the scanning geometry directly from the point-cloud and allows computing the final quality indicator for every laser point directly in the flight (Schaer et al., 2008; Skaloud and Schaer, 2010; Skaloud et al., 2010). In the context of airborne laser scanning (ALS), however, the laser measurements are rarely used as single values. Instead a laser point-cloud is considered as a discretized representation of a continuous surface. The transfer from a single point measurement to a surface model calls for new concept of quality assurance and quality control. Such measures shall reflect not only the quality of individual target points but also the data coverage and the distribution of point density with respect to the model.

This contribution presents surface-related quality indicators describing the confidence-metrics of the final geo-products derived from airborne laser scanning. We first discuss the factors influencing the quality of the digital terrain models (DTM). Apart the previously mentioned quality of individual laser targets we consider other factors as classification, sampling density and interpolation. Finally, we propose a novel procedure that enables an automated generation of a DTM quality map encapsulating all these factors assuming that the following conditions are fulfilled: i) the accuracy of each ground point involved in DTM generation is known or derived (Schaer et al., 2008); ii) the DTM is represented as a regular grid where the height values are calculated by projecting the grid-cell center coordinates on the corresponding facet of the TIN-model which nodes are the irregularly sampled laser-points reflected from the ground. The derived DTM-quality map is thus influenced by the choice of grid resolution with respect to the actual density of the laser-point cloud. In other words, shall the laser point-cloud density be inferior to the minimum sampling frequency required to restitute the DTM at certain resolution, the rigorously derived height-accuracy per grid-cell are scaled up to reflect that fact that extrapolation has taken place. Finally, we present several examples that demonstrate surface-quality maps computed for an ALS point-cloud where the distribution of automatically classified ground points is very disparate and contains important gaps due to dense vegetation or insufficient surface-reflectance. These quality-maps indicate areas where the height values are reliable and areas where they should be consider with precaution. We conclude with suggestions on possible applications of such quality-maps that can be associated as metadata to the DTM. We argue that they represent additional value when estimating the accuracy of DTM derived quantities (i.e. slope, aspect) and in constructing rigorous weighting schemes when merging DTMs of different accuracies and/or from diverse sources.

References

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