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Towards Automation in Landcover Mapping from LiDAR Data in Alpine Environment

Peter Dorninger (1), Christian Briese (1,2), Clemens Nothegger (1,2), and Armin Klauser (2)

(1) Vienna University of Technology, Christian Doppler Laboratory "Spatial Data from Laser Scanning and Remote Sensing", Vienna, Austria (pdo@ipf.tuwien.ac.at / +43-1-58801-12299), (2) Vienna University of Technology, Insitute of Photogrammetry and Remote Sensing, Vienna, Austria

Digital terrain models derived from airborne LiDAR (often referred to as airborne laser scanning) are commonly used for various applications in geomorphology. The ongoing development in sensor technology makes flight campaigns with some 10 points per square meter economically feasible for large areas. Simultaneously, the achievable accuracy of the originally acquired points as well as those of the derived products increases due to improved measurement techniques. Additionally, full-waveform (FWF) laser scanning systems record the time-dependent strength of the backscattered signal. This allows for the determination of numerous points (i.e. echoes) for one emitted laser beam hitting multiple targets within its footprint. Practically, about five echoes may be determined from the digitized signal form. Furthermore, additional attributes can be determined for each echo. These are, for example, a reflectivity measure (amplitude), the widening of the echo (echo width), or the sequence of the echoes of a single shot. By considering the polar measurement range and atmospheric conditions, a physical calibration of such measurements is possible. The application of FWF information to increase the accuracy and the reliability of digital terrain models especially in areas with dense vegetation was shown by Doneus & Briese (2006).

However, these additional attributes are rarely used for object or landcover classification. This is still the domain of automated image interpretation (e.g. Zebedin et al., 2006). Nevertheless, image interpretation has well known deficiencies in areas with vegetation or if shadows occur. Therefore, we tested a hybrid approach which uses conventional first echo / last echo (FE/LE) airborne laser scanning data (first and last pulse) and an RGB-orthophoto. The testing site is located in an alpine area in Tyrol, Austria. For the classification, topographic models, a slope map, a local roughness measure and a penetration ratio were determined from the laser scanning data. Additionally, a vegetation index was derived from the orthophoto. Using a supervised classification approach based on well known testing sites, the following classes could be determined: forest, dwarf-pines, grass land, debris, and bare rock. After a generalization step, we compared the results to two existing topographic landcover maps showing high correlation. However, the method showed several shortcomings in shadowed areas in the orthophoto. Furthermore, a separation of debris and bare rock was only possibly by a slope threshold.

To overcome these problems, we investigated another testing site, situated in the alpine region of Lower Austria, Austria. The data was acquired by a Riegl LMS-Q560 FWF laser scanner. In this case we did not use an orthophoto. Instead we considered additional parameters derived from the FWF data. These were a distance corrected amplitude and the pulse width, and, especially in regions with high vegetation, multiple echoes were available. Furthermore, we derived highly robust local tangential planes for each point (Nothegger & Dorninger, 2008). Due to those tangential planes being computed in three-dimensions, the computation of the slope angles, especially in steep regions, becomes more reliable. Additionally, quality parameters provided by the plane estimation were considered for the classification. For example, the local roughness measure indicates vegetation.

So it could be demonstrated that point based classification of LiDAR data allows for landcover classification in alpine areas. To achieve reliable results from FE/LE laser scanning data, the integration of image data was necessary. However, this introduced typical shortcomings of geomorphological interpretation in vegetation and shadowed areas. The use of FWF laser scanning allows overcoming these shortcomings and increasing the automation of reliable landcover mapping including the characteristics of alpine geomorphic features.

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