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4D Near Real-Time Environmental Monitoring Using Highly Temporal LiDAR

Bernhard Höfle (1), Ekrem Canli (2), Evelyn Schmitz (1), Sophie Crommelinck (1), Dirk Hoffmeister (1), and Thomas Glade (2)

(1) Department of Geography, GIScience, Heidelberg University, Heidelberg, Germany (hoefle@uni-heidelberg.de), (2) Department of Geography and Regional Research, University of Vienna, Vienna, Austria (ekrem.canli@univie.ac.at)

The last decade has witnessed extensive applications of 3D environmental monitoring with the LiDAR technology, also referred to as laser scanning. Although several automatic methods were developed to extract environmental parameters from LiDAR point clouds, only little research has focused on highly multitemporal near real-time LiDAR (4D-LiDAR) for environmental monitoring. Large potential of applying 4D-LiDAR is given for landscape objects with high and varying rates of change (e.g. plant growth) and also for phenomena with sudden unpredictable changes (e.g. geomorphological processes).

In this presentation we will report on the most recent findings of the research projects 4DEMON (http://uni-heidelberg.de/4demon) and NoeSLIDE (https://geomorph.univie.ac.at/forschung/projekte/aktuell/noeslide/). The method development in both projects is based on two real-world use cases: i) Surface parameter derivation of agricultural crops (e.g. crop height) and ii) change detection of landslides. Both projects exploit the "full history" contained in the LiDAR point cloud time series.

One crucial initial step of 4D-LiDAR analysis is the co-registration over time, 3D-georeferencing and time-dependent quality assessment of the LiDAR point cloud time series. Due to the high amount of datasets (e.g. one full LiDAR scan per day), the procedure needs to be performed fully automatically. Furthermore, the online near real-time 4D monitoring system requires to set triggers that can detect removal or moving of tie reflectors (used for co-registration) or the scanner itself. This guarantees long-term data acquisition with high quality.

We will present results from a georeferencing experiment for 4D-LiDAR monitoring, which performs benchmarking of co-registration, 3D-georeferencing and also fully automatic detection of events (e.g. removal/moving of reflectors or scanner). Secondly, we will show our empirical findings of an ongoing permanent LiDAR observation of a landslide (Gresten, Austria) and an agricultural maize crop stand (Heidelberg, Germany). This research demonstrates the potential and also limitations of fully automated, near real-time 4D LiDAR monitoring in geosciences.