Geophysical Research Abstracts
Vol. 17, EGU2015-2885-2, 2015
EGU General Assembly 2015

Permanent 3D laser scanning system for an active landslide in Gresten (Austria)

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Terrestrial laser scanners (TLS) have widely been used for high spatial resolution data acquisition of topographic features and geomorphic analyses. Existing applications encompass different landslides including rockfall, translational or rotational landslides, debris flow, but also coastal cliff erosion, braided river evolution or river bank erosion. The main advantages of TLS are (a) the high spatial sampling density of XYZ-measurements (e.g. 1 point every 2-3 mm at 10 m distance), particularly in comparison with the low data density monitoring techniques such as GNSS or total stations, (b) the millimeter accuracy and precision of the range measurement to centimeter accuracy of the final DEM, and (c) the highly dense area-wide scanning that enables to look through vegetation and to measure bare ground.

One of its main constraints is the temporal resolution of acquired data due to labor costs and time requirements for field campaigns. Thus, repetition measurements are generally performed only episodically. However, for an increased scientific understanding of the processes as well as for early warning purposes, we present a novel permanent 3D monitoring setup to increase the temporal resolution of TLS measurements. This accounts for different potential monitoring deliverables such as volumetric calculations, spatio-temporal movement patterns, predictions and even alerting. This system was installed at the active Salcher landslide in Gresten (Austria) that is situated in the transition zone of the Gresten Klippenbelt (Helvetic) and the Flyschzone (Penninic). The characteristic lithofacies are the Gresten Beds of Early Jurassic age that are covered by a sequence of marly and silty beds with intercalated sandy limestones.

Permanent data acquisition can be implemented into our workflow with any long-range TLS system offering fully automated capturing. We utilize an Optech ILRIS-3D scanner. The time interval between two scans is currently set to 24 hours, but can be set as low as a full scan requires. The field of view (FoV) from the fixed scanner position covers most of the active landslide surface (with a maximum distance of 300 m). To initiate the scan acquisition, command line tools are run automatically on an attached notebook computer in the given time interval. The acquired 3D point cloud (including signal intensity recordings) are then sent to a server via automatic internet transfer. Each new point cloud is automatically compared with an initial ‘zero’ survey. Furthermore, highly detailed reference surveys are performed several times per year with the most recent Riegl VZ-6000 scanner from multiple scan positions in order to provide high quality independent ground truth. The change detection is carried out by fully automatic batch processing without the need for manual interaction. One of the applied change detection approaches is the M3C2 algorithm (Multiscale Model to Model Cloud Comparison) which is available as open source software.

The field site in Gresten also contains different other monitoring systems such as inclinometers and piezometers that complement in the interpretation of the obtained TLS data. Future analysis will include the combination of surface movement with subsurface hydrology as well as with climatic data obtained from an on-site climatic station.