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Quantification of 3D landslide displacement derived from multi-temporal long-range terrestrial laser scanning

Thomas Zieher (1), Jan Pfeiffer (2), and Martin Rutzinger (1)

(1) Austrian Academy of Sciences, Institute of Interdisciplinary Mountain Research, Innsbruck, Austria (martin.rutzinger@oeaw.ac.at), (2) University of Innsbruck, Institute of Geography, Innsbruck, Austria

Deep-seated landslides pose a threat to residential structures in mountain areas all over the world. In order to prevent harmful events, their activity needs to be monitored. For this task various monitoring techniques are employed. In contrast to other monitoring techniques (e.g. based on a differential global navigation satellite system or using a tachymeter) 3D point clouds sequentially acquired by remote sensing techniques can provide area-wide coverage with a high accuracy (range of cm to dm). Multi-temporal terrestrial laser scanning (TLS) is particularly suited for monitoring landslides in vegetated areas. In the present study, the movement of the Reissenschuh landslide in the Schmirn valley (Tyrol, Austria) is quantified based on point clouds acquired with a Riegl VZ6000 long-range laser scanner in 2016 and 2017. Objects (tree stems, blocks, ridges) traveling on top of the landslide are extracted from the acquired point clouds based on local morphometric attributes. Their corresponding representations in the multi-temporal data are exploited for the derivation of 3D displacement vectors. The subsequent analysis reveals spatial patterns of enhanced landslide movement, corresponding well with distributed measurements based on a differential global navigation satellite system (DGNSS). The main challenges are to (i) automatically extract objects and features, (ii) establish object correspondences in the multi-temporal data and (iii) derive significant displacements well above the uncertainty of the acquired data. These issues are presented and discussed in detail. Further research will focus on improving the identification and tracking of single objects in the multi-temporal point clouds.

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