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# Comparative analysis of landslide kinematics using ground-based optical images and terrestrial laser scanning

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High-resolution multi-temporal digital surface models (DSMs) acquired by ground-based optical images and terrestrial laser scanner (TLS) are used in combination to estimate the three-dimensional surface deformation and displacements of the Super-Sauze landslide (South French Alps) during a period of two months (June-July 2010). The analysis is part of a field experiment with the objective to characterize the relationship of small fracture processes with slope movement, fissure developments and pore water pressure build-up. Long-term observations of the average displacement rate at the investigated area (about 10.000 $m^2$) are greater than 0.01 $m.day^{-1}$.
During the monitoring period, 3D point clouds were acquired with an Optech ILRIS-3D TLS system at different dates. On the same days, several optical images (2816 x 2112 pixels) were taken by a low-cost digital camera to test the validity of advanced photogrammetric algorithms for precise data acquisitions. Additionally, DGPS measurements were carried out in order to geo-reference and validate the point cloud data.
The investigated area with an elevation difference of about 50 m is characterized by large relief irregularities (flattened areas, blocks, small gullies). These irregularities lead to shadowed zones and finally to gaps in the acquired point clouds. Nine laser scans from four different viewpoints with an average point spacing between 10 to 30 mm were acquired in order to minimize these undesired gaps. In a final processing step all TLS-point clouds were merged and geo-referenced.
About 70 optical images were taken on points along a predefined line on the side part of the landslide. To maximize the coverage, a point to point distance of 10 m and different viewing directions were chosen. The distance between camera and relevant area ranges from 5 to 60 m. The photogrammetric point cloud was then generated from all images by applying a new feature-based multi-view stereo approach which does not require any ground control point information. To determine the quality of the photogrammetric DSMs, the point clouds were compared with the LiDAR-based DSMs.
The surface deformation over a period of eight weeks was determined by comparison of the photogrammetric DSM, the TLS-based DSMs as well as the 3D-displacement vectors calculated from the DGPS coordinates.