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Correlation image velocimetry applied to multitemporal LiDAR data for automated landslide movement assessment

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Landslides are common in mountainous regions posing a serious risk to human life. Spatially distributed displacement and activity assessment is crucial for understanding and modelling complex landslide driving processes.
The dynamic behaviour of the Valoria landslide, an active earthslide-earthflow located in the Northern Apennines of Italy was assessed for the last 5 years. For this purpose, digital image correlations were computed based on high resolution topographic data. Results were compared with periodic GPS observations, visual interpretations and survey data derived from a continuous topographic monitoring system.
Automated image comparisons are based on correlation image velocimetry (CIV) measuring displacements of characteristic pixels that occur between image acquisitions. The technique was applied to slope maps of high-resolution, multi-temporal digital elevation models (DEMs). Planar displacements computed for the 2006/07 and 2007/09 correlations were corrected to account for elevation offsets. Calculations were carried out using open source software tools. The performance of FFT-based and direct cross correlation-based algorithms was evaluated. Sub-pixel accuracy was calculated, i.e. by using a three-point Gaussian fit. Spurious results were eliminated through manual filtering and by using signal-to-noise ratios.
For both slope-based image correlations magnitude and azimuth of displacements at selected areas of the Valoria landslide could be reconstructed. Impressive results could be computed for areas characterized by low velocities. From 2006 to 2007 the main flow was subject to maximum displacements of up to 13 m within 8 months. For the source areas up to 20 meters were obtained. The image correlation of the 2007/2009 DEMs was restricted due to the large time interval spanning between the DEM acquisitions. Only a large block slide in the toe zone yielded well constrained results with displacement up to 51 meters in only 26 months. The results provide valuable and complementary information when surface monitoring data are spatially and temporally limited.