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Multi-temporal terrestrial laser scanning for identifying rockslide modifications: potentialities and problems

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The heart of this research is to provide an efficient methodology for a reliable acquisition and interpretation of Terrestrial Laser Scanner (TLS) data in the application field of landslide monitoring. In particular, rockslides, which are characterized by vertical walls of rock and by a complex morphology, are of great concern in the study. In these cases the airborne laser scanning is not able to provide useful and reliable description and the terrestrial laser scanning might be the only possible choice to obtain a good and reliable description of the geomorphology or to identify the changes occurred over time. The last purpose is still a challenging task when long distances are involved because the accurate and punctual identification of displacements is not possible due to the laser beam divergence.
The final purpose of the research is a proposal of a methodology which is based on TLS technology for identifying displacements and extracting geomorphological changes. The approach is clearly based on a multi-temporal analysis which is computed on several repetitions of TLS surveys performed on the area of interest. To achieve best results and optimize the processing strategy, different methods about point clouds alignment have been tested together with algorithms both for filtering and post-processing.
The case study is the Collagna Landslide that is located in the North Appennines (Reggio Emilia, Italy) on the right flank of Biola torrent. The large scale composite landslide area is made both by a wide rock slide sector and a more limited earth slide sector that, after high precipitation rates, disrupted the National Road 63 in December 2008. An integrated monitoring system is installed since 2009 and comprises both point-based technologies such as extensometers, total station and global positioning system, and also area-based technologies such as airborne laser scanner, long-range TLS and ground-based radar. This choice allows to couple the advantages of both approaches. The research focuses on TLS surveys for trying to detect displacements which might be responsible for instability. Four point clouds acquired in the last two years allow to monitor the spatial displacements of the whole slope, especially focusing on the rockslide sector. It is worth to underline an important aspect which contributes to highlight the significance of the work: the mean scanning distance is about 1.3 km. Few examples exist in literature about the use of very long-range TLS for displacements investigation. By sequentially analyzing TLS surfaces, displacement maps have been obtained for the rockslide area. Confirmation have been achieved by comparing results with movements of reflectors sited on the entire slope and continuously measured by total station. Such validation strengthens the idea that TLS has serious potentialities to be successfully used for analyzing instability. Comparing surfaces is not easy at all, thus a discussion about the encountered problems will be taken into account: any significant detail about potentialities and difficulties of the alignment strategy and the processing procedure will be given together with details about the specific algorithm implemented for filtering displacements by taking into account actual geomorphological conditions.