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Point cloud accuracy, survey techniques and the performance of automated rock discontinuity extraction and analysis

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In the last decade, the development of methods and algorithms for the semi-automated and automated extraction of rock discontinuities from 3D point clouds has provided new opportunities to improve the quality, safety and reliability of rock mass characterization for rock engineering applications. While much attention has been paid to the improvement of algorithms, there is still a need to identify the requirements that 3D point clouds should meet to optimize the performance of automated analysis. In this perspective, using high-resolution 3D point clouds obtained by Terrestrial Laser Scanning and photogrammetry, we compared the results of an original automated analysis code with a dataset of discontinuity attributes collected in the field.

We characterised rock discontinuities exposed at a 7m-high and 20m-long paragneiss outcrop near Colico (Como Lake, Italy), using both window and scanline field mapping techniques. We performed very close range TLS surveys from 6 scan positions 4m away from the outcrop, with an angular accuracy of 0.04° resulting in a point spacing within 10 mm. Moreover, we carried out a photogrammetric strip survey from 14 camera stations with a 4m range, using a 12 Mpix reflex camera and an 18mm lens. Structure-from-Motion processing allowed obtaining dense point clouds with point spacing of about 1.5 mm and reprojection errors within 0.5 pixel. We georeferenced both TLS and photogrammetric point clouds using the same reference targets and DGPS survey with post-processing. We characterised and compared the obtained point clouds in order to assess the influence of the survey and generation techniques on the represented 3D outcrop geometry. Then, we performed automated structural analyses of the point clouds using ADAM (Automated Discontinuity Analysis Method), an original Matlab toolset (Bianchetti et al. 2016) to automatically identify and extract individual planar patches, classify them into discontinuity sets, and measure populations of spacing and persistence values. By comparing the results obtained by ADAM with ground truth (field data), we discuss the influences of point cloud accuracy, survey technique and pre-processing techniques on the performance of different parts of automated discontinuity analysis (orientation, spacing, persistence), in order to propose criteria to optimize data collection and processing.