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2D quantitative analysis of fractures from high-resolution photos for the geomechanical characterization of rock masses

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The identification of discontinuity sets and their properties is among the key factors for the geomechanical characterization of rock masses, which is fundamental for performing stability analyses, and for planning prevention and mitigation measures as well.
In practice, discontinuity data are collected throughout difficult and time-consuming field surveys, especially when dealing with areas of wide extension, difficult accessibility, covered by dense vegetation, or with adverse weather conditions. Consequently, even experienced operators may introduce sampling errors or misinterpretations, leading to biased geomechanical models for the investigated rock mass.
In the last decades, new remote techniques such as photogrammetry, *Light Detection and Ranging* (LiDAR), *Unmanned Aerial Vehicle* (UAV) and *InfraRed Thermography* (IRT) have been introduced to overcome the limits of conventional surveys. We propose here a new tool for extracting information on the fracture pattern in rock masses, based on *remote sensing* methods, with particular reference to the analysis of high-resolution georeferenced photos. The first step consists in applying the *Structure from Motion* (SfM) technique on photos acquired by means of digital cameras and UAV techniques. Once aligned and georeferenced, the orthophotos are exported in a GIS software, to draw the fracture traces at an appropriate scale. We developed a MATLAB routine to extract information on the geostructural setting of rock masses by performing a quantitative 2D analysis of the fracture traces, based on formulas reported in the literature. The code was written by testing few experimental and simple traces and was successively validated on an orthophoto from a real case study.
Currently, the script plots the fracture traces as polylines and calculates their orientation (strike) and length. Subsequently, it detects the main discontinuity sets by fitting an experimental composite Gaussian curve on histograms showing the number of discontinuities according to their orientation, and splitting the curve in simpler Gaussian curves, with peaks corresponding to the main discontinuity sets.
Then, for each set, a linear scanline intersecting the highest number of traces is plotted, and the apparent and real spacing are calculated. In a second step, a grid of circular scanlines covering the whole area where the traces are located is plotted, and the mean trace intensity, trace density and trace length estimators are calculated.

It is expected to test the presented tools on other case studies, in order to optimize them and calculate additional metrics, such as persistence and block sizes, useful to the geomechanical characterization of rock masses.
As a future perspective, a similar approach could be investigated for 3D analyses from point clouds.