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Remote analysis of cliff outcrops using laser DDSM and digital images

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Risk due to rock fall in cliff areas pose critical problems to be properly identified and estimated. This is partly due to the difficulty to perform surface observations on scarps. We have tested a new investigation method which aims at giving a fracture analysis on such outcrops with a simple remote approach based on solid images, a combination of co-registered image and laser scanning data. Compared to a photogrammetric approach, a solid image interpretation is simpler to implement, quicker to use and do not require special training.

Important structural features may be ignored or misread when texturing a DDSM (Dense Digital Surface Model) with radiometric data because its leads to erode the resolution of the original image. Avoiding this problem, the solid image approach keeps the image in its original geometry and resolution and re-projects DDSM data (like point clouds obtained from laser scanning systems) on the image itself. If the point clouds are enough dense, this allows us to localize each pixel. Measurements like plane orientation can then be easily made by selecting areas and computing the best fitting plane. Following the trace of fractures or bedding planes on outcrop images directly gives a 3D digitizing of the trace. There are many other applications of solid images in remote structural analysis. Most of them have been implemented for our purposes as applets in “Image-J”, public domain software.

All three studied sites are located near Grenoble, France: the “Roche du Midi” and the “Rocher de la Bourgeoise” sites correspond to scarps of the Vercors massif whereas the “Ravin de l’Aguille” site lies in the Chartreuse massif. Due to the geometry of each site, different strategies both for the laser scanning and the image acquisition

have been used. In two cases we used terrestrial laser scanning systems whereas in one case airborne (helicopter) scanning system was used.

The main results are as follow:

- Data coming from the solid image analysis are similar to those directly measured in the field and to those coming from a photogrammetric analysis. Except in special cases, the same fractures families are identified, with the same accuracy.
- When the laser highlights the outcrop with an orientation parallel to a specific fracture family, this family can not be identified on the solid image. As a consequence, when using terrestrial laser scanning, we recommend using at least two solid images computed from two different points of view.
- The accuracy of the airborne laser scanning being ten times lower than the accuracy in the terrestrial process, the smallest fracture that can be oriented on such solid images is much larger.