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Permafrost long-term monitoring network

WP6 Permafrost and Natural Hazards
Action 6.1 – Method sheet

Terrestrial photogrammetry (TP)

Michèle CURTAZ[1]

General information	
Category	Remote sensing
Background	terrestrial
Basic principles	
Technology	Photogrammetry is based on stereo or multi-image restitution of a block of overlapping images: collinearity equations allow to determine the 3D model of the overlapped area. A sequence of overlapping images is acquired with calibrated digital cameras. Georeferencing and block control is obtained, depending on hardware and processing facilities: (i) measuring a set of ground control points by total station or GPS; (ii) determining the camera position by a GPS tied to the camera and synchronized with the image acquisition (*photo-GPS* technique).
Data processing	Homologous image point coordinates are measured (manually or automatically by image correlation software) in every image. Bundle block adjustment provides image orientation. Object point coordinates are determined by tri-angulation or multiple intersection. Softwares based on Dense Matching algorithms provide a high resolution Digital Surface Model (DSM) of the object. The diachronic comparison of DSM models, performed by specific softwares, allow to analyse and measure changes in shape and volume of the examined object.
Possible applications	
Why?	Detection and quantification of morphological changes, monitoring, quantitative interpretation, displacement rates measurements
What?	Rock walls, rock glaciers, moraines, landslides, glacial debris-cover
Where?	High mountain, inaccessible study objects
Main results	
- High resolution 3D models (possibly georeferenced) - Map of morphological changes - Identification and quantification of mass movements - Extraction of geometric features for structural and geomechanical analysis	

[1] Fondazione Montagna Sicura - 1, Loc. Villard de la Palud - 11013 Courmayeur - Italy - MCurtaz@fondms.org

Main advantages

- High resolution (depending on the survey parameters adopted)
- High precision (centimeter)
- Easy and fast data acquisition
- Object size range: cm-km
- Possibility to get data on subvertical or overhanging rock walls
- Low cost in comparison with other techniques (any calibrated high resolution camera with interchangeable optics)
- Easy transportability on site

Main disadvantages/problems

- Data processing is fairly long and complex
- Highly specific softwares and operator'sexpertise
- Need a good visibility of the object (no cloud between the camera and the object, no trees nor dense vegetation); only the areas visible in at least two images can be obtained in the DSM
- Resolution and precision strongly influenced by the geometry of the survey (camera positions, distance from the object)
- Measurement of control points rather difficult in some cases

References

Kraus K., 1997. *Photogrammetry. Vol. 1: Fundamentals and Standard Processes ; Vol. 2: Advanced Methods and Applications.* Dümmler, Bonn.

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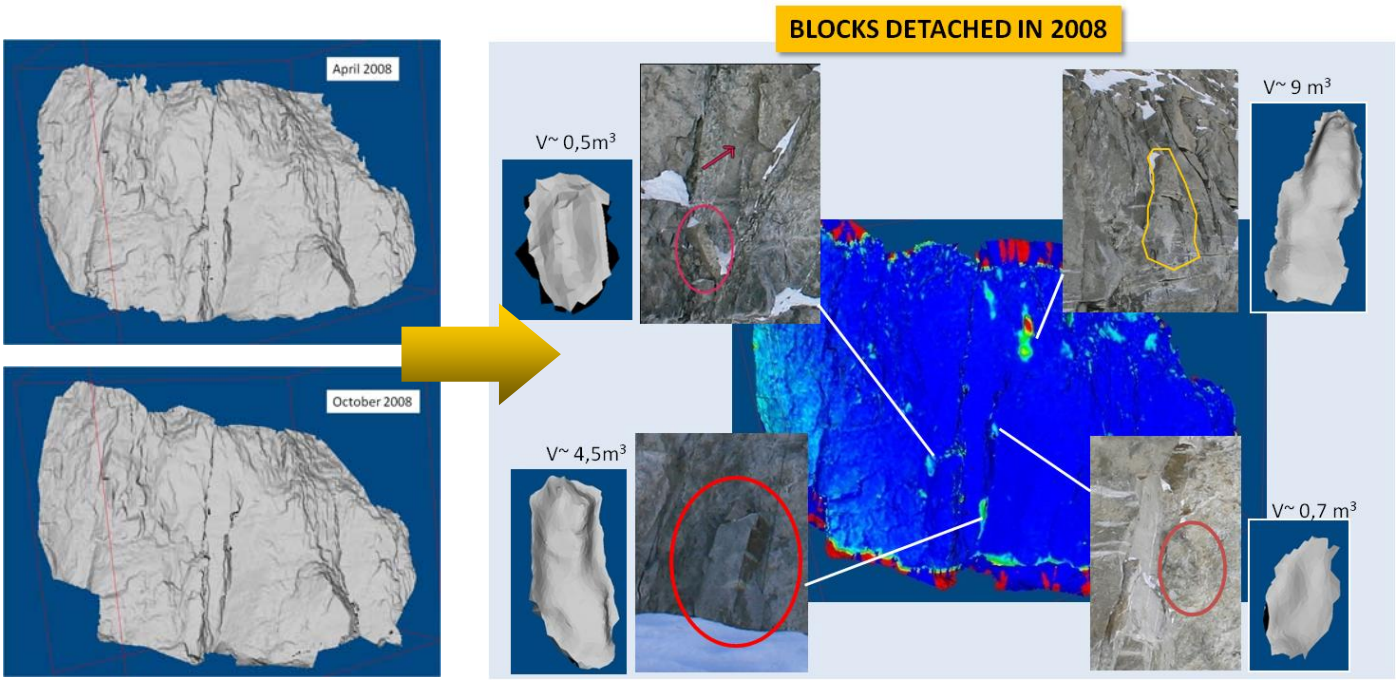
Roncella R., Forlani G., Remondino F., 2005. Photogrammetry for geological applications: automatic retrieval of discontinuity orientation in rock slopes. *In*: Beraldin J.A., El-Hakim S.F., Gruen A., Walton J. (Eds*), Videometrics VIII, Proceedings SPIE-IS&T Electronic Imaging, SPIE*, 5665: 17-27.

High resolution digital camera (Nikon D700) coupled to GPS for the photo-GPS technique used at Aiguilles Marbrées North face (Mont Blanc massif).



Comparison of the 2008 DSMs of lower part of Aiguilles Marbrées North face: four small blockfalls were detected using VRmesh *software during that summer.*