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Time-lapse stereo-photogrammetric monitoring of volcanic slopes

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Piton de la Fournaise volcano (La Reunion Island) due to its crater collapse of April 2007 which created 200m to 300-m-high sub-vertical cliffs in a matter of minutes offers a rare opportunity to observe the morphological fingerprint of numerous rock avalanches. In the framework of ANR-Undervolc, a research project funded by the French Research Council to investigate geophysical determinants of volcano construction and destruction, a pair of time lapse photogrammetric packages was deployed along the active crater edge in October 2009. In this talk, we will discuss the qualitative and quantitative benefits and short-comings of time lapse stereo monitoring based on an hourly photo sequences captured between 28 December 2009 and 15 April 2010. In short, time synchronization between cameras must be guaranteed in order to capture the space and time location of detected objects, failure to do so results in erroneous instantaneous 3D locations. Synchronization requirement depends on the velocity of the monitored object. Visual change detection, by compiling movies from still shots, is hampered by the changing illumination of the scene throughout the day. To lessen its impact, we recommend making movies at constant time of day when the sun angle changes only on a slower seasonal time scale. For quantitative change detection, the stereoscopic capabilities of the camera setup enabled automated extraction of hundreds of Digital Surface Models (DSM). This was achieved by combining generating Photomodeler Scanner instruction from Matlab, though the so-called Dynamic Data Exchange (DDE) protocol. Three cases were investigated: DSM sequences of rock avalanche corridors, rockfall scar detection and eruption volume quantification. The volume of January 2010 volcanic eruption came out to $1\,597\,200 \pm 95\,660 \text{ m}^3$, i.e. a relative precision of 6%. Time-lapse stereo photogrammetry holds promises for in-situ geomorphological monitoring despite a few creases still needing ironing out.