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Near-automatic generation of lava dome DEMs from photos

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Acquiring accurate digital elevation models (DEMs) of growing lava domes is critical for hazard assessment. However, most techniques require expertise and time (e.g. photogrammetry) or expensive equipment (e.g. laser scanning and radar-based techniques). Here, we use a photo-based approach developed within the computer vision community that offers the potential for near-automatic DEM construction using a consumer-grade digital camera and freely available software.

The technique is based on a combination of structure-from-motion and multi-view stereo algorithms (SfM-MVS) and can generate dense 3D point clouds (millions of points) from multiple photographs of a scene taken from different positions. Processing is carried out by automated 'reconstruction pipeline' software downloadable from the internet, e.g. http://blog.neonascent.net/archives/bundler-photogrammetry-package/. Such reconstructions are initally un-scaled and un-oriented so additional software (http://www.lancs.ac.uk/staff/jamesm/software/sfm_georef.htm) has been developed to permit scaling or full georeferencing. Although this step requires the presence of some control points or knowledge of scale within the scene, it does not have the relatively strict image acquisition and control requirements of traditional photogrammetry. For accuracy and to allow error analysis, georeferencing observations are made within the image set, rather than requiring feature matching within the point cloud.

Here we demonstrate the results of using the technique for deriving 3D models of the Volcán de Colima lava dome. 5 image sets have been collected by different people over a period of 12 months during overflights in a light aircraft. Although the resulting imagery is of variable quality for 3D reconstruction, useful data can be extracted from each set. Scaling and georeferencing is carried out using a combination of ortho-imagery (downloaded from Bing) and a few GPS points. Overall precisions are $\sim$1 m and DEM qualities are sufficient to quantify dome loss and talus gain from small rockfall sites, as well as to highlight the structural evolution of the upper surface of the dome as it collapses.