Moiré projection and advanced photogrammetry for 3D monitoring subtle deformations in laboratory models

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Abstract

Geodesists use advanced geodetic monitoring techniques to record ground deformation patterns associated with earthquakes and volcanic eruptions. In the laboratory, however, small displacements are not trivial to monitor at high spatial and time resolution, especially in 3D. During this presentation, I will introduce two techniques I set up on an experimental apparatus dedicated to simulate shallow magma emplacement processes.

The first technique is called moirÃ© projection, and consists of coupled computer-controlled video projector and video camera. The projector projects a series of frames made of straight black and white fringes of varying thicknesses. When projected onto a non-flat surface, the fringes are not straight any more, and the resulting fringe pattern is monitored with the video camera, and subsequently analysed to compute a DEM. This technique allows a monitoring period down to 1.5 s, and can detect very small displacements (0.2 mm out of a 40x40 cm model).

The second technique is based on photogrammetry. In classical photogrammetric methods, the cameras need to be calibrated and their positions measured accurately. In comparison, this technique calibrates and computes the camera positions, and subsequently computes high resolutions 3D point clouds, providing the topography of the monitored object and the image texture superimposed to the topography. Such dataset is used subsequently to perform 3D PIV to compute 3D displacement fields.