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Traking of Laboratory Debris Flow Fronts with Image Analysis

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Image analysis technique is applied to track the time evolution of rapid debris flow fronts and their velocities in laboratory experiments. These experiments are parts of the project avaflow.org that intends to develop a GIS-based open source computational tool to describe wide spectrum of rapid geophysical mass flows, including avalanches and real two-phase debris flows down complex natural slopes. The laboratory model consists of a large rectangular channel 1.4m wide and 10m long, with adjustable inclination and other flow configurations. The setup allows investigate different two phase material compositions including large fluid fractions. The large size enables to transfer the results to large-scale natural events providing increased measurement accuracy.
The images are captured by a high speed camera, a standard digital camera. The fronts are tracked by the camera to obtain data in debris flow experiments. The reflectance analysis detects the debris front in every image frame; its presence changes the reflectance at a certain pixel location during the flow. The accuracy of the measurements was improved with a camera calibration procedure. As one of the great problems in imaging and analysis, the systematic distortions of the camera lens are contained in terms of radial and tangential parameters. The calibration procedure estimates the optimal values for these parameters. This allows us to obtain physically correct and undistorted image pixels. Then, we map the images onto a physical model geometry, which is the projective photogrammetry, in which the image coordinates are connected with the object space coordinates of the flow. Finally, the physical model geometry is rewritten in the direct linear transformation form, which allows for the conversion from one to another coordinate system. With our approach, the debris front position can then be estimated by combining the reflectance, calibration and the linear transformation. The consecutive debris front position at different frames also allows obtaining the evolving debris front velocities.

Project web site: http://www.avaflow.org/