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A quality assessment of 3D video analysis for full scale rockfall experiments

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Main goal of full scale rockfall experiments is to retrieve a 3D trajectory of a boulder along the slope. Such trajectories then can be used to calibrate rockfall simulation models. This contribution presents the application of video analysis techniques capturing rock fall velocity of some free fall full scale rockfall experiments along a rock face with an inclination of about 50 degrees. Different scaling methodologies have been evaluated. They mainly differ in the way the scaling factors between the movie frames and the reality and are determined. For this purpose some scale bars and targets with known dimensions have been distributed in advance along the slope. The single scaling approaches are briefly described as follows:

(i) Image raster is scaled to the distant fixed scale bar then recalibrated to the plane of the passing rock boulder by taking the measured position of the nearest impact as the distance to the camera. The distance between the camera, scale bar, and passing boulder are surveyed.

(ii) The image raster was scaled using the four nearest targets (identified using frontal video) from the trajectory to be analyzed. The average of the scaling factors was finally taken as scaling factor.

(iii) The image raster was scaled using the four nearest targets from the trajectory to be analyzed. The scaling factor for one trajectory was calculated by balancing the mean scaling factors associated with the two nearest and the two farthest targets in relation to their mean distance to the analyzed trajectory.

(iv) Same as previous method but with varying scaling factors during along the trajectory.

It has shown that a direct measure of the scaling target and nearest impact zone is the most accurate. If constant plane is assumed it doesn't account for the lateral deviations of the rock boulder from the fall line consequently adding error into the analysis. Thus a combination of scaling methods (i) and (iv) are considered to give the best results. For best results regarding the lateral rough positioning along the slope, the frontal video must also be scaled. The error in scaling the video images can be evaluated by comparing the data by additional combination of the vertical trajectory component over time with the theoretical polynomial trend according to gravity.

The different tracking techniques used to plot the position of the boulder's center of gravity all generated positional data with minimal error acceptable for trajectory analysis. However, when calculating instantaneous velocities an amplification of this error becomes un acceptable. A regression analysis of the data is helpful to optimize trajectory and velocity, respectively.