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Semi-automatic determination of rockfall trajectories

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For more accurate prediction of rockfall trajectories it is necessary to calibrate and validate numerical model simulations with a large amount of data from real experiments. Relevant data include the trajectories, accelerations and the rotational motion of a moving rock. The current state of the art is to reconstruct trajectories using high-speed video recordings. However, precise determination of acceleration and rotation is nearly impossible. Furthermore, video analysis is a very time consuming process also requiring an unobstructed view of the moving object. These limitations are delaying our ability to systematically evaluate trajectory models.

To improve our ability to measure trajectories, we designed a new sensor, in collaboration with an external manufacturer, which can be installed in natural rocks. It contains a 3D accelerometer (500g range), a 3D rotation sensor (2000°/s), both sampled at 1'000Hz and – as the main innovation – a local positioning system (LPS). The LPS functions similar to GPS: a moving sender emits signals which are recorded by multiple synchronized receivers placed around the testing site. From these data the 2D position (i.e. no height information) is calculated at a resolution of 10Hz. We expect the trajectories to have an accuracy of 0.5m to 1m.

The limited range of the LPS signal and the requirement of an unobstructed field of view between the sensor and LPS-receivers are two limitations at the present. Nevertheless, the determination of the acceleration and the rotation of the moving rock allow us to constrain and better interpret the LPS data and further describe details of the boulder-ground interactions.

In this presentation we describe the initial tests of the general functionality of the system in 1D and 2D laboratory experiments and in 3D real-terrain experiments. These first results are very promising. We also describe our evaluations of the maximum obtainable precision of this sensor/LPS system.