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Epic imagery for four-dimensional trajectory reconstruction of real-scale rockfall experiments

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We present an in-depth reconstruction of the full set of parameters of interest in single block rockfall trajectories. The comprehensive process understanding of rockfall kinematics holds not only the promise to enhance the application of numerical models for engineering hazard analysis but is equally important to investigate wider cascade problems in steep terrain. We present a full four-dimensional trajectory reconstruction of single block induced rockfall experiment.

In-situ accelerometer and gyroscope data [1,2,3] are combined with videogrammetric and unmanned aerial systems mapping techniques to understand the role of rock rotations, ground penetration and translational scarring in rockfall motion [4]. Main focus are two reconstruction methods: (1) A simple a posteriori impact mapping (AIM) method is presented, where flight parabola reconstruction is performed via extracting lift-off and impact points together with their corresponding time intervals from a single video stream. (2) A dense cloud reconstruction (DCR) where a three-dimensional dense cloud is calculated for each image pair originating from temporally synchronized RED Epic 8K (8192x4320 pixels), 25 frames/sec, video streams. Rock extraction is performed via a select-by-colour query within the PhotoScan Software from Agisoft.

The exhaustive target tracking and succeeding trajectory reconstruction provides information over the complete flight path such as translational velocity vectors, angular velocities, impact duration and forces, ballistic jump heights and lengths. The experimental data provides insight into the basic physical processes detailing how rotating rocks of general shape penetrate, rebound and scar ground terrain. The data serves in future as a calibration foundation to enhance numerical rockfall modelling allowing novel calibration routines for numerical rockfall models, independent of their implementation method. The adequate simulation of change of kinematics during the impact becomes of key importance in order to match realistic rockfall behaviour. The presented reconstruction methodologies pave the way to a comprehensive parameter study on real-scale rockfall events and serves as complementary calibration possibility to the present back-calculation of case studies.

KEYWORDS: rockfall experiments, 4D trajectory reconstruction, videogrammetry, target tracking

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