ETH zürich

Analyzing Velocities in Debris Flows using 3D Laser Scanners
Illgraben, Switzerland

Bachelor's Project Proposal

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Debris flows are extremely rapid, flow-like landslides composed of fine and coarser-grained components, boulders, woody debris as well as water. They are characterized by large impact forces as well as long runout distances and are one of the most dangerous types of mass movements in mountainous regions. Managing the risk posed by this type of landslide is particularly important for alpine countries like Switzerland, where debris flows have caused major damage and led to numerous fatalities in the past.

More detailed field-scale measurements of natural debris flows are required to better understand the fundamental mechanisms governing debris-flow motion and, ultimately, to reduce the associated risks in the future. However, such measurements of moving debris flows – and in particular of their velocity – are generally rare. Investigating the distribution of velocities within a debris flow is crucial as it controls the discharge and thus the volume of an event. These are both important parameters in practical debris-flow hazard assessment.

The measurements of debris-flow velocity performed in the proposed project are based on high-resolution, high-frequency 3D point clouds from laser scanners (Ouster LiDAR sensors). These sensors were originally developed for driverless cars and have been installed in the Illgraben (Valais, Switzerland), one of the most active debris-flow catchements in the Alps, for debris-flow monitoring in 2021 (Figure 1). The student working on this project will analyze point-cloud data from one or multiple debris flows recorded by a laser scanner at the Illgraben to investigate the velocity of these flows. In particular, the student will use Matlab to track features visible at the surface of the flow (Figure 2) and to determine the velocities of these objects. For this purpose, point-cloud data of recent debris-flow events will be provided along with existing Matlab scripts, which can be modified and improved by the student.

The findings of this Bachelor's project will have important implicatinos for the understanding of debris-flow dynamics as well as for the measurement of hazard-related parameters such as discharge and volume. No special skills are required, however an interest in natural hazards is considered an asset and some programming experience (Matlab or Python) will be helpful. Furthermore, the student will likely have the opportunity to visit the Illgraben (Figure 1) in order to understand the sensor array and to potentially help with sensor calibration works.

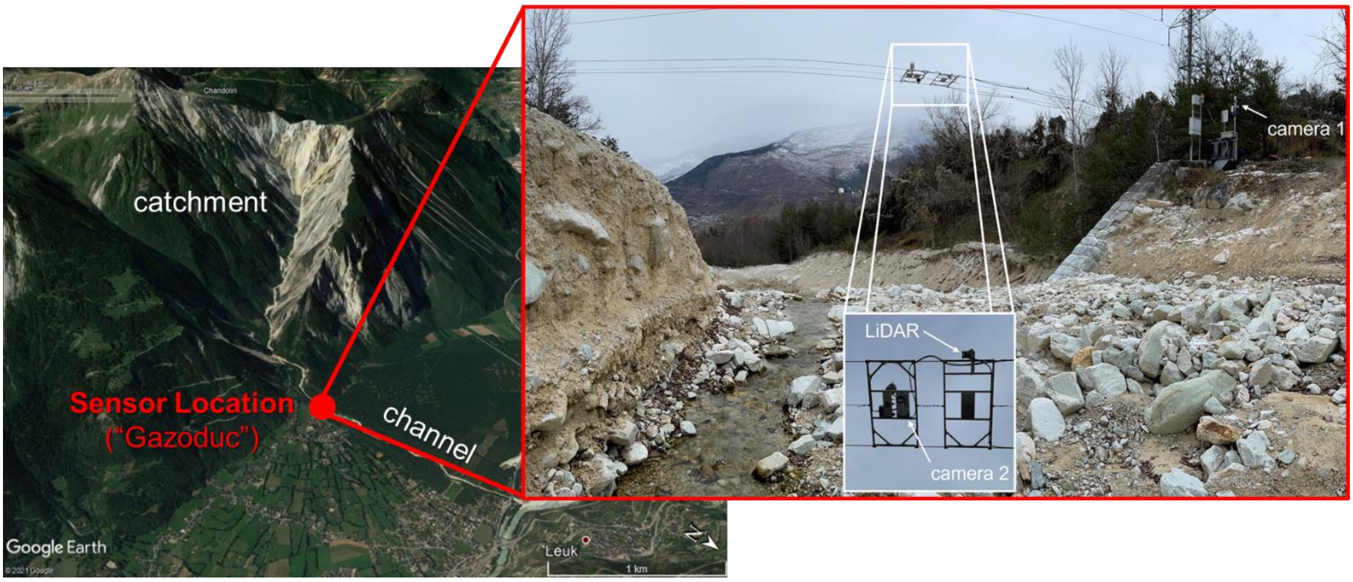

Figure 1: Overview of a monitoring station ("Gazoduc") with a 3D laser scanner (LiDAR) in the Illgraben, one of the most active debris-flow catchments in the Alps.

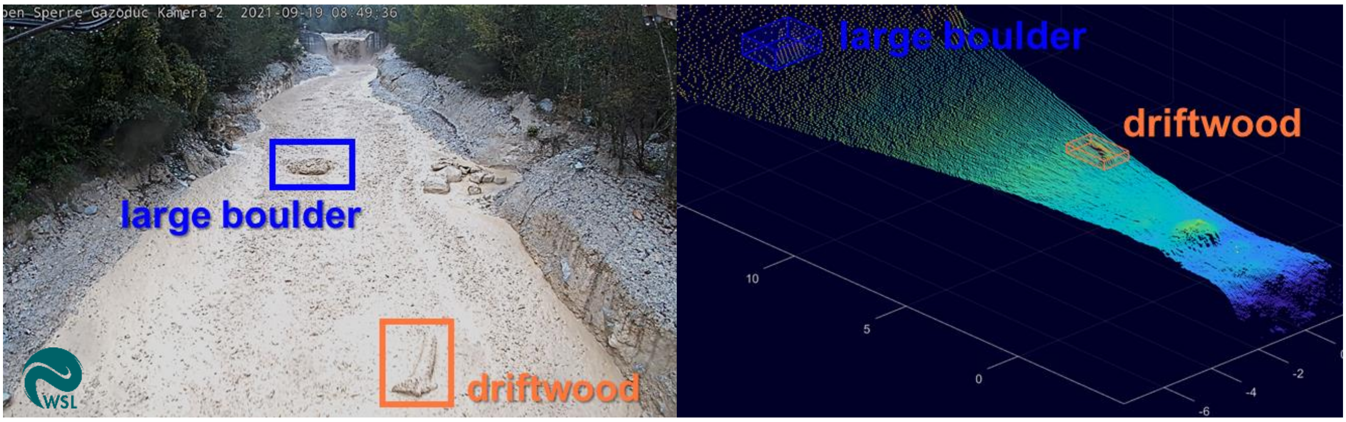

Figure 2: Example of objects (large boulder and piece of woody debris) identified in a debris flow, in a camera image (left) and in a 3D LiDAR point cloud (right).

For questions and applications, please contact:

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