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Application of the Unity Game Engine and Other Open-Source 3D Tools to Rockfall Modelling with Fragmentation and Talus Debris Interaction

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Rockfall is a variable process which involves the detachment of isolated blocks or masses of rock from steep, natural and constructed slopes. This process poses risks to susceptible downslope infrastructure such as homes, pipelines, and railways. To properly manage this risk, rockfall modelling is often performed, attempting to understand the potential runout and impact energy of rockfall debris. As part of ongoing research into the impact of geotechnical hazards affecting Canadian railways, a 3D rockfall simulation tool has been developed using the Unity game engine [1][2]. This technique allows for the creation of realistic simulations using high-resolution site data collected from remote sensing techniques such as terrestrial laser scanning and oblique aerial structure-from-motion photogrammetry.

In combination with ongoing model calibration work, further model development is being done, focusing on areas such as simulated rockfall shape and fragmentation, as well as the entrainment of moving rock blocks in on-slope debris. The work presented here demonstrates our ability to now simulate rockfall trajectory using detailed rockfall geometries, reconstructed from pre- and post-fall remote sensing datasets. These detailed geometries can be intersected with structural features such as joints mapped from high-resolution site imagery and measured directly from the point cloud data, creating a source rockfall object which more closely represents the fractured state of the pre-failure source mass. Furthermore, using voronoi fracture networks, individual blocks in the generated source mass are able to fragment as they exit the source zone and impact surfaces downslope. Using a similar fracturing process in the open-source 3D modelling software Blender, simulated rigid body debris accumulations on the slope can be generated. Currently these accumulations are being explored as a method for simulating block-debris entrainment, arresting blocks in simulated clasts of talus on the slope as opposed to using inflated friction and roughness parameters, or lower restitution values. The overall goal of this work is moving towards a more realistic rockfall modelling method which fully leverages the quality and 3D geometry of the high-resolution point cloud data which can currently be collected for hazardous rock slopes.

[1] Ondercin, M.: An Exploration of Rockfall Modelling Through Game Engines, M.A.Sc Thesis, Queen's University, Kingston, 2016

[2] Sala, Z., Hutchinson, D. J., Ondercin, M., 2017. Game Engine Based Rockfall Modelling Techniques Applied to Natural Slopes. Proceedings: GeoOttawa 2017, Ottawa, ON, October 1-4, 2017