Unmanned Aerial Vehicles (UAVs) for Improved Rock Mass Structural Data Acquisition and Analysis

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The utilization of UAVs is improving the safety and statistical underpinning of rockfall hazard analysis. Traditional rappelling techniques involve serious risk, are time consuming, and can result in statistically biased structural datasets. A further difficulty is that measuring structural orientations using the "window" method can introduce statistical bias by only examining a subset of a rock face. We have had good success with photogrammetrically derived UAV datasets using precisely programmed flight planning, multiple camera angles, and surveyed ground control points. The resultant photogrammetrically derived point clouds can then be analyzed with existing software packages to extract the orientations of planar features (e.g. joint sets) for further analysis. Additionally, the dense 3D coverage facilitates quantitative approximation of block volumes, thus helping in design of energy absorbing and other rockfall mitigations. The rock face DTM enhances analysis of runout trajectories and is importable into multiple software.

By programming a vertically gridded flight plan that is offset from the outcrop face by less than 50 feet, we can obtain a high resolution orthomosaic and high density point cloud. We conduct multiple flights using the same grid nodes but with camera angles on successive flight adjusted to be roughly orthogonal to major structure populations. This leads to increased resolution of the structural surfaces themselves and of the traces of structures on the outcrop face while also greatly reducing data gaps. Incorporating surveyed ground control into the model is critical to georeferencing and extracting accurate spatial data.

A major advantage of this data acquisition technique is that it readily provides datasets that are usable in existing rockfall hazard analysis. We did not have to re-invent the existing software that is used to extract structural data from the point cloud. We continue to test the various variables in the process, and to better characterize resolution and accuracy.