An optimized method of unmanned aerial vehicle surveying for rock slope analysis, 3D modeling, and structural feature extraction

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Accurate and detailed mapping of structural geology is integral to the analysis of rock bodies for the design and construction of engineered rock slopes. Unmanned aerial vehicles (UAVs) can be used to complement traditional mapping techniques. UAVs can be used to map high walled or unstable slopes where safety considerations prevent human mappers from accessing the face. Additionally, significantly larger slopes can be mapped in less time, using a UAV.

A methodology is presented here using a camera-equipped quadcopter style UAV, coupled with DGPS ground points to produce a 3D photogrammetric point cloud and TIN model. Subsequently, discontinuity orientations are extracted from the point cloud model. Various commercial and open-source discontinuity extraction algorithms are tested for accuracy against joints set orientations measured with a compass.

The data processing variables tested in the photogrammetry point cloud generation stage include parameters for photo alignment and dense cloud generation. The photo alignment parameters are accuracy, pair preselection, key point limit, and tie point. Dense cloud generation variables tested are quality (point cloud density), and depth filtering. Additionally, variables tested in the Kd-Tree discontinuity extraction algorithm include maximum angle between neighboring patches, maximum distance between the merged patches and the current facet center, maximum difference of elevation for entities in a facet, minimum points per facet, and distance of facet influence from points. Optimal processing parameters will vary, depending on the relative size of exposed discontinuity dip-surfaces, relative to the point cloud density.

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