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Automated surface detection in 3D point clouds: comparison between terrestrial and aerial derived photogrammetry datasets

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The use of 3D outcrop datasets provides ever greater quantities of geological information, however with increased data volume we need to be aware of the uncertainty in the accuracy of these detailed models and how they affect the derived geological data. While 3D point clouds have been traditionally created using terrestrial laser scanning, structure-from-motion has emerged as a faster/easier alternative to producing rich datasets from geological outcrops. However, the quality and usability of the data depends heavily on the exact techniques and equipment used.

We use automated surface extraction algorithms to derive fracture planes from a quarry face surveyed using three different data collection workflows. The results are compared and analysed to ascertain advantages and disadvantages between the different methods in terms of the geological outputs. The data comes from a ca. 12 m high by ca. 35 m wide fractured carboniferous limestone quarry face in Weardale, UK. The outcrop was surveyed using a UAV, at different distances, one at ca. 20 m and the other at ca. 85 m, and a hand held SLR camera, collected along the base of the cliff. The outcrop was spatially referenced using GNSS ground control with sub-cm relative accuracy. The fracture extraction algorithm was used on the three point cloud models in order to understand the importance of subtle changes in fidelity and data quality on the ability to create meaningful and representative fracture datasets. The digital datasets are appraised against outcrop observations to asses which model is closest to geological reality. The study shows how the different methods introduce uncertainty into the extracted geological information.

The outcrop contains two dominant fracture sets with one other minor set. The outcrop is layered and the fractures exploit the mechanical stratigraphy. The automated code is designed to identify the multiscale nature of fracture systems and simultaneously captures both bed-bound- and non-bedbound fractures within multiple sets. Factors that control the quality of the derived fracture network include data shadowing, positional noise, and consistent point density across the outcrop. The results of the study can be used to improve survey design and also highlights the ability of the automated surface extraction techniques to identify geologically realistic fracture surfaces in a quick and cost-effective fashion.