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An Orientation Based Correction Method for SfM-MVS Point Clouds—Implications for Field Geology

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Abstract.

Advancements in computing capabilities over the last decade have allowed for the routine creation of Structure from Motion-Multiview Stereo (SfM-MVS) terrain models that can serve as base for high resolution geologic mapping. Outcrops models developed from these systems are high-resolution, photo-realistic 3D base providing unprecedented capability for geometric analysis. Yet, before this technology becomes a mainstay of field geology, the potential errors associated with it must be well understood. Here, we compare orientation measurements from multi-point analyses on the SfM-MVS point clouds to those taken in the field with the objective of resolving the geometry of complex folds within the outcrop. We also analyzed two point clouds of the same exposure created from different ground-based cameras to compare the ranges of error. We found that the point clouds produced from ground-based photos exhibited significant rigid-body rotation relative to the real world despite well distributed ground control, yet the models maintained a realistic scale and internal geometry. To correct the error the model values were rotated and the discrepancy reassessed. The two point clouds produced similar results, however, the Sony compact-digital-camera-based point cloud ultimately corresponded more closely to field values. We suggest that the primary cause of the error in the point clouds was GPS-based and was enhanced by the lack of significant topographic relief in our camera positions, allowing rigid-body rotations along the axis of the photographic array. This outcome suggests that care must be taken when GPS errors are a significant fraction of the outcrop size and relatively 2D outcrops imaged by a relatively 1D image array are subject to rotation errors that are difficult to remove without high-resolution ground control. Short of using a UAV and/or RTK-GPS we show how this can be resolved simply by collecting several known orientations in the field, which can then be used to orient the model more accurately, akin to ground control points. This addition is a key step if this method is to be used for more thorough analysis and is a general method that could be used to orient virtual outcrops with no geographic reference.

1.1 Introduction

Advancements in technology over the past decade have changed the way geoscientists both acquire and display their data, leading to a revolution in the performance of field mapping (Pavlis et al., 2015; Cawood et al., 2017; Pavlis and Mason, 2017). Digital-mapping techniques leverage the modern dissemination of imagery and digital elevation data, and they provide a medium for large-scale geologic features to be interpreted. More importantly, recent developments in photogrammetry allow