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Application of SfM-MVS for mining geology: Capture set-up and automated processing using the Dugald River Zn-Pb-Ag mine as a case study

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ABSTRACT

The use of structure-from-motion, multi-view stereo (SfM-MVS) in the mining industry is well-established for capturing digital data on surface. However, the application of SfM-MVS in active underground mining has received less attention as there are unique challenges that need to be overcome, especially if a procedure is to be applied daily in active mining. Unique challenges include preparation time, camera positioning, illumination and useability. The faces of active development drives are generally only available for a short period before prepared and blasted, thus information is lost if not mapped immediately. Furthermore, due to safety concerns, unsupported faces cannot be approached for physical mapping. SfM-MVS allows these faces to be viewed and mapped in the form of a virtual outcrop, thus, allowing for remote mapping of underground development, which at the Dugald River mine, located in Queensland, Australia, allowed for mapping continuity as staff worked remotely during COVID-19. This contribution describes how to set-up a capture in an underground mine to produce high-quality SfM-MVS 3D reconstructions of development faces. The methodology can be readily incorporated into a standard operating procedure. While the procedure can be used with most photogrammetry software packages that utilise SfM-MVS algorithms, it is best utilised using the provided Python script and Agisoft Metashape Professional v1.6. The script allows for automation of capture processing, which can free up several hours per day compared to user-interacted processing.

1. Introduction

Digital mapping as part of the mining process has become an increasingly important tool for data gathering. Widespread techniques include face photography, stereophotography, structure-from-motion multi-view stereo (SfM-MVS), light detection and ranging (LiDAR) and hyperspectral imaging. In recent years numerous research papers and conferences have discussed the application of digital data capture techniques in Geoscience (Allmendinger et al., 2017; Assali et al., 2014; Bemis et al., 2014; Cawood et al., 2017; James et al., 2017; James and Robson, 2012; Johnson et al., 2014; Novakova and Pavlis, 2017; Vollgger and Cruden, 2016; Whitmeyer et al., 2019), with the use of photogrammetry in underground mining gaining attention (García-Luna et al., 2019; Slaker and Mohamed, 2017; Whaanga et al., 2019). They cover a wide range of topics including comparisons between different digital techniques (e.g. Assali et al., 2014; Cawood et al., 2017), structural data collection using smart phones (e.g. Allmendinger et al., 2017; Whitmeyer et al., 2019) and comparisons between digital and traditional (i.e. structural compass, pen and paper) mapping techniques. In general, most authors agree that digital mapping delivers similar results as traditional mapping, and the observed differences can be eliminated by improving sensors, devices, and algorithms.

Studies on surface outcrop are usually done where lighting, rock exposure and environmental conditions are optimal for data capture, or can be delayed until environmental conditions are favourable. In underground mining, environmental conditions, including humidity and dust are variable, and due to ongoing mining activity, data collection must be performed within tight timeframes. For example, the face of an active drive can be prepared and charged for firing at the subsequent shift-change. Thus, the on-duty Mine Geologist is typically the only Geoscientist that will see and record the information from the face. This information is commonly recorded using hand sketches, which may be rushed, untidy and subjective with structural orientations estimated rather than measured due to safety reasons as an unsupported face may not be approached (Robertson, 2017). Furthermore, automation and smart mining is increasingly becoming vital due to stricter mining

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