A Deep Learning Based Approach for Roof Bolt Recognition in 3D Point Cloud of Underground Mines

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Keywords: Roof bolts, 3D point cloud, Deep learning, Classification, Mine roof monitoring

ABSTRACT

Roof bolts are an essential component of roof support systems in underground mines. They are used to provide structural support to the roof of the mine and prevent it from collapsing. Therefore, it is imperative to perform regular assessments of these roof bolts to avert any hazards. Manual investigations of roof bolts are done by surveyors in underground mines, which is extremely time consuming and challenging due to the low-light conditions in underground mines accompanied by stringent mine access rules. To this end, automated recognition of roof bolts in 3D point cloud data obtained through laser scanning in underground mines serves as a potential solution to aid roof bolt monitoring.

Where previous studies have used feature engineering and traditional machine learning based approaches for detection of roof bolts, this study, for the first time, explores the viability of using deep learning-based approach for the classification of roof bolts within 3D point cloud data, obtained via laser scanning in underground mines. The methodology involves extracting features from the point cloud data and distinguishing between roof bolts and other elements. The deep learning model developed for this purpose undergoes thorough training, testing, and validation using data acquired from a mining site. To assess the effectiveness of this approach, its outcomes are compared against manually collated ground truth data. This comparison involves generating a confusion matrix from the test area dataset. Additionally, standard classification metrics such as accuracy, precision, and recall are employed to evaluate the approach's quality. Implementing this automated approach could substantially enhance the safety of underground mining operations by offering a more reliable and efficient means of roof bolt detection.