Underground Roof Bolt Identification from 3D LiDAR Scanning Data

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ABSTRACT

Roof bolts have been wildly used to enhance the structural stability of underground mines. However, due to the complex environment in underground tunnels, like humidity, roof bolts can deform and corrode over time. Therefore, monitoring the geolocation and deformation of roof bolts is important for the safety of mines. LiDAR instruments, which works well under suboptimal lighting conditions and are portable, for example it can be installed on trucks or carried by workers, have capability of identifying and geolocating underground rock bolts. Though, LiDAR has been used for underground three-dimensional mapping, using LiDAR scan data to identify underground objects, such as rock bolts, has rarely been investigated. In deep learning filed, lots of models have been developed for 3D object classification and segmentation. Considering the success of 3D object identification in deep learning field, in this research, we aim to develop a deep learning model which achieves identification and geolocation of rock bolt from the underground LiDAR point cloud. Detecting small 3D object from point cloud is quite challenging, for example, in our application scenarios, there are around 2 million points in one LiDAR scan whereas a single rock bolt may only contain around 300 points due to the scan resolution. To identify the rock bolts from such large background, we adopt a two-step method. The first step pre-processes the original scan data and tries to filter as much background points as possible. In the second step, neural networks are applied to further identify rock bolts. The bolts detected by our algorithm are used to produce compliance figures which indicate the degree of fulfilment of designed rock bolt plan. The compliance figures can aid in identifying trends and planning reworks in problematic areas.