Advances in vibration monitoring of mining equipment with deep machine learning methods

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# ABSTRACT

Vibration signal analysis plays a critical role in the predictive maintenance of mining equipment. It involves the continuous monitoring of oscillatory motion, typically in rotating machinery, to detect abnormalities or deviations from normal operating conditions. By analysing the vibrations emitted by mining equipment, maintenance managers can gain real-time insights into the health of the machinery, allowing them to identify potential issues before they lead to significant failures.

Several methods are employed in vibration analysis, including time-domain analysis, frequency-domain analysis, modal analysis, and envelope analysis. Each method provides unique insights into the condition of the equipment, helping to pinpoint specific faults or irregularities. For instance, frequency-domain analysis can identify specific frequencies associated with faults, while envelope analysis is particularly effective for detecting bearing defects and gear faults.

Vibration signal analysis faces several challenges, primarily due to the complexity and variability of the signals involved. One major challenge is the detection of minor faults in their early stages, which can be difficult, owing to the subtle nature of the changes in vibration patterns. The variability in operating conditions and the presence of noise in the data further complicate the analysis, making it hard to distinguish between normal operational variations and actual faults.

Machine learning, particularly deep learning techniques, can play a pivotal role in addressing these challenges. Convolutional neural networks (CNNs) and other deep learning models can automatically extract features from large volumes of raw vibration data, which helps in identifying patterns and anomalies that might be missed by traditional methods.

In this investigation, the potential of pretrained vision transformers in mining and mineral processing are discussed, given their ability to detect incipient changes in vibration signals that are not otherwise identifiable.