Applications of Multi-modal Human Activity Recognition to Enhance Worker Safety in Underground Mines

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ABSTRACT

The underground mine environment is inherently complex and hazardous, which necessitates ensuring mining workers' safety. With the fast development of Artificial Intelligence techniques, human activity recognition has become a crucial task to enhance daily life, especially in such challenging settings. This enables automatic monitoring and detection of the mine workers' activities and operations on a large scale, which leads to better support of workers' safety and welfare. Existing traditional uni-modal approaches suffer from low data quality and noise, so they struggle to generalize effectively in such extreme conditions. As underground mines have extreme and complicated environments, such as dust, low light, signal interference, and rugged terrain, uni-modal approaches could not resolve such obstacles and are not suitable for real-world deployment. Multi-modal human activity recognition approaches could utilize data from multi-modal sources, thus capturing complementary information and producing robust and effective performance in recognizing and monitoring mining activities. In this case, designing suitable multi-sensor hardware and AI activity recognition models has become a pivotal task. Also, producing efficient multi-modal approaches for edge deployment is another problem worth exploring. In this work, we introduce and discuss the challenges and solutions of conducting human activity recognition in underground mine environments and present the human activity recognition solution in a multi-modal scenario. The approach involves multi-modal data processing and utilizing attention-based deep learning methods to extract the salient information, thus producing effective results along with robust generalization ability. The knowledge obtained from this work provides insight into integrating and analyzing multi-sensory data to recognize and monitor activity data, emphasizing its role in maintaining workplace safety and operational efficiency in the underground mine setting. In conclusion, this work underscores the necessity and effectiveness of multimodal human activity recognition approaches in underground mines, emphasizing their critical role in ensuring safety and operational efficiency. This work not only addresses the unique challenges of underground mine environments but also paves the way for advanced human-computer collaboration in industrial settings.