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On Enabling Miner Self-Rescue with In-Mine Robots using Real-Time Object Detection with Thermal Images

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Abstract : Surface robots in modern underground mine rescue operations suffer from several limitations in enabling a prompt self-rescue. Therefore, the possibility of designing and deploying in-mine robots to expedite miner self-rescue can have a transformative impact on miner safety. These in-mine robots for miner self-rescue can be envisioned to carry out diverse tasks such as object detection, autonomous navigation, and payload delivery. Specifically, this paper investigates the challenges in the design of object detection algorithms for in-mine robots using thermal images, especially to detect people in real-time. A total of 125 thermal images were collected in the Missouri S&T Experimental Mine with the help of student volunteers using the FLIR TG 297 infrared camera, which were pre-processed into training and validation datasets with 100 and 25 images, respectively. Three state-of-the-art, pre-trained real-time object detection models, namely YOLOv5, YOLO-FIRI, and YOLOv8, were considered and re-trained using transfer learning techniques on the training dataset. On the validation dataset, the re-trained YOLOv8 outperforms the re-trained versions of both YOLOv5, and YOLO-FIRI.

Keywords : miner self-rescue, object detection, underground mine, YOLO
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