Advanced Visual Fusion in Mining: Infrared and Visible Light Integration and Enhancement

Chengpei Xu[1] *and Binghao Li*[2]

1.Postdoc Fellow, MERE, UNSW, Sydney. Chengpei.Xu@unsw.edu.au:
2.Associate Professor, MERE, UNSW, Sydney. Binghao.Li@unsw.edu.au:

Keywords: Infrared and Visible Light Fusion and Enhancement, Mining Environment Perception, Data Analysis in Degraded Conditions.

ABSTRACT (USE 'HEADING 1' STYLE)

In subterranean environments like tunnels and mines, achieving effective visual perception under challenging conditions is crucial. While LiDAR has been a go-to technology for spatial mapping and object detection, its limitations in low-light conditions, sensitivity to environmental factors such as dust, and inability to capture color information mark significant drawbacks. Our research introduces a novel approach that leverages the synergistic fusion of infrared (IR) and visible light, transcending the capabilities of conventional LiDAR systems in these environments. This fusion harnesses the penetrating capabilities of IR imaging in low or no-light conditions, a crucial advantage in poorly lit underground settings.

We propose a deep learning based constrained learning formulation, unrolled into a target-aware network for fusion, enhancement and a standard detection network, focusing on preserving structural information from infrared images and textural details from visible images. When coupled with the rich color and detail rendition of visible light, our dual-modality approach significantly outperforms the monochromatic and dust-sensitive nature of LiDAR. Moreover, the computational efficiency of processing IR and visible light data, compared to the intensive demands of 3D LiDAR, facilitates real-time analysis and decision-making.

Our solution addresses the critical need for robust, cost-effective visual systems in mining operations. By enhancing image quality and details even in dust-laden atmospheres. The integration of IR and visible light not only improves operational safety by offering enhanced environmental perception but also ensures the retention of vital color information, enhancing both human interpretability and machine vision efficiency.