Innovative Approaches to Dust Pollution Management in Mining Operations: A Comprehensive Image-Based Identification and Evaluation System

JJ Yin[1] and SF Wang[2]

1. Cent South Univ, Sch Resources & Safety Engn, Changsha 410083, Hunan, Peoples R China. Email: jj.yin@csu.edu.cn
2. Cent South Univ, Sch Resources & Safety Engn, Changsha 410083, Hunan, Peoples R China. Email: sf.wang@csu.edu.cn

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ABSTRACT

Dust pollution poses a persistent challenge within mining processes, giving rise to a spectrum of concerns, including occupational diseases, mechanical degradation, diminished visibility, and the potential for dust explosion incidents. Existing methodologies for dust detection and monitoring face limitations, including insufficient measurement accuracy and intricate processing procedures. Consequently, a comprehensive identification and evaluation system rooted in image processing technology is proposed to facilitate real-time measurements of dust pollution in mining worksites.

The study primarily employs grayscale average and fractal dimension to characterize particle features evident in collected dust images. As a result, the data processing platform can dynamically process data and present dust pollution condition. Notably, this research integrates the monitoring and assessment of dust pollution with the systematic adjustment of mining parameters, ventilation parameters, and strategies for dust reduction. Through statistical analysis of dust concentration and particle size during mining processes, rock properties such as components and cuttability can inform mining parameters. This information, in turn, guides detailed excavation strategies, including cutterhead speeds, torque, and excavation speed.

Similarly, the analysis of dust characteristics derived from images serves as a valuable resource for gaining deeper insights into the efficacy of implemented ventilation strategies. By harnessing vision-based information detailing dust concentration and distribution, a wealth of direct guidance becomes available for refining ventilation parameters. This encompasses crucial aspects such as the selection of appropriate ventilation systems tailored to the specific mining environment and the optimization of operational conditions for ventilation fans. Additionally, the detailed information derived from the visual data allows for strategic decisions on factors like the spatial arrangement of ventilation outlets and the calibration of airflow rates.

Moreover, precise choices for dust reduction measures and parameters can be made based on the prevailing dust conditions. Upon real-time monitoring of dust pollution using the proposed method, corresponding measures such as spraying and foaming can be promptly implemented. Crucial parameters, such as spray angles and volume, are integral to these application processes. In essence, the proposed method assumes a pivotal role in not only dust monitoring but also the formulation of preventative and control measures within mining processes.