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An Advanced Image-Based Intelligent System for Enhancing Construction Site Safety Monitoring and Analysis

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Abstract : In the construction industry, safety is of paramount importance given the complex and dynamic nature of construction sites, which are prone to various hazards like falls from heights, being hit by falling objects, and structural collapses. Traditional safety management strategies such as manual inspections and safety training have shown significant limitations. This study presents an intelligent monitoring and analysis system for construction site safety based on an image dataset. A specifically designed Construction Site Safety Image Dataset, comprising 10 distinct classes of objects commonly found on sites, is utilized and divided into training, validation, and test subsets. InceptionV3 and MobileNetV2 are chosen as pre-trained models for feature extraction and are modified through truncation and compression to better suit the task. A novel Feature Fusion architecture is introduced, integrating these modified models along with a Squeeze-and-Excitation block. Experimental results demonstrate that the proposed model achieves a mean Average Precision (mAP) of 0.81 at an IoU threshold of 0.5, with high accuracies for classes like "Safety Cone" (91%) and "Machinery" (93%) but relatively lower accuracy for "Vehicle" (57%). The training process exhibits smooth convergence, and compared to prior methods such as YOLOv4 and SSD, the proposed framework shows superiority in precision and recall. Despite its achievements, the system has limitations, including reliance on visual data and dataset imbalance. Future research directions involve incorporating multi-modal data, conducting real-world deployments, and optimizing for edge deployment, aiming to further enhance construction site safety.

Keywords : construction site safety, intelligent monitoring system, image dataset, InceptionV3, MobileNetV2, feature fusion, squeeze-and-excitation block, mean average precision, object detection
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