

## Brief Motivation

Ensuring safety compliance on construction sites is crucial, as lapses can lead to severe injuries or fatalities. Traditional safety inspections are often time-consuming and rely heavily on manual oversight, which can miss violations and delay corrective actions. With the advancement of AI technology, there is an opportunity to enhance site safety by automating the detection of essential PPE (Personal Protective Equipment) compliance, such as helmets, masks, and vests. This project aims to develop an AI-powered system that ensures workers adhere to safety protocols, thereby reducing risks and fostering a safer work environment.

## Objective

To create an AI-based system that monitors PPE compliance on construction sites by detecting safety violations in real-time and logging them for review. The main objectives are:

- **Real-Time Detection:** Instantly identify individuals lacking essential PPE, including helmets, masks, and vests.
- **Automated Alerts:** Issue corrective instructions via speakers to non-compliant individuals to prompt immediate action.
- **Comprehensive Logging:** Maintain a log of all violations to support safety audits and monitor trends.
- **Scalability:** Enable deployment on large construction sites, covering multiple areas simultaneously.
- **Data Security:** Ensure secure storage and handling of sensitive data, protecting the privacy of workers.

## Methodology

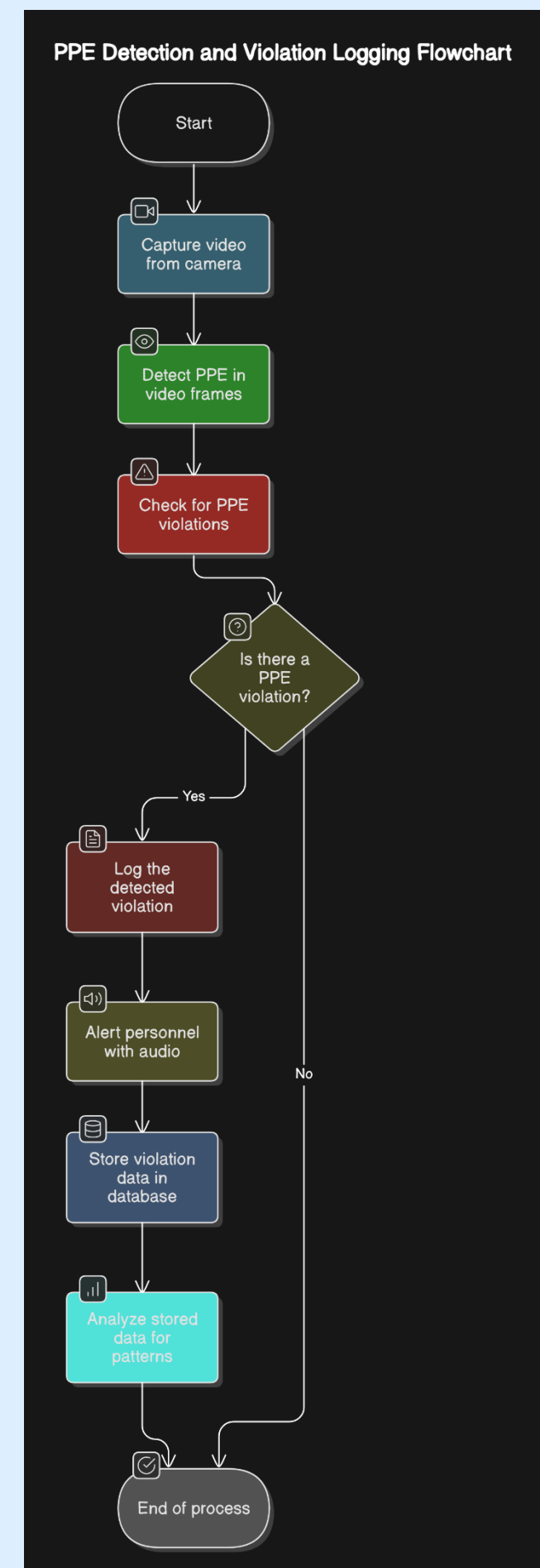
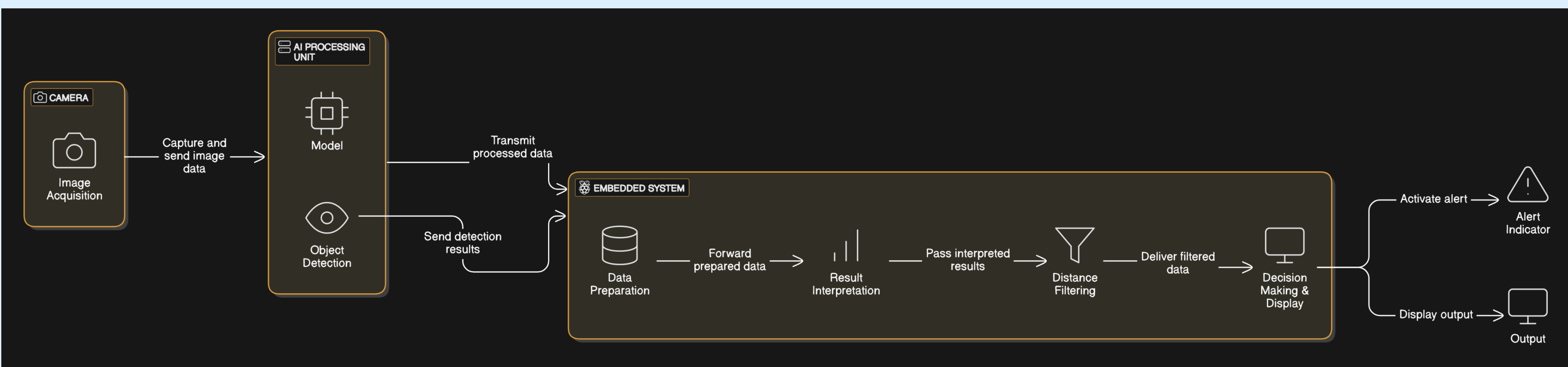
**System Architecture Overview:** The PPE Detection and Violation Logging System is designed to monitor, detect, and log instances where Personal Protective Equipment (PPE) compliance is not met, enhancing workplace safety in real-time.

**Object Detection Model:** Using a trained object detection model, the system analyzes the processed frames to identify the presence of PPE, such as helmets, masks, and safety vests. Detected PPE or any violations are sent for further processing.

**Detection Pipeline:**

**Pre-processing and Forward Propagation:** The captured frames are fed into the detection model, where potential violations are identified.

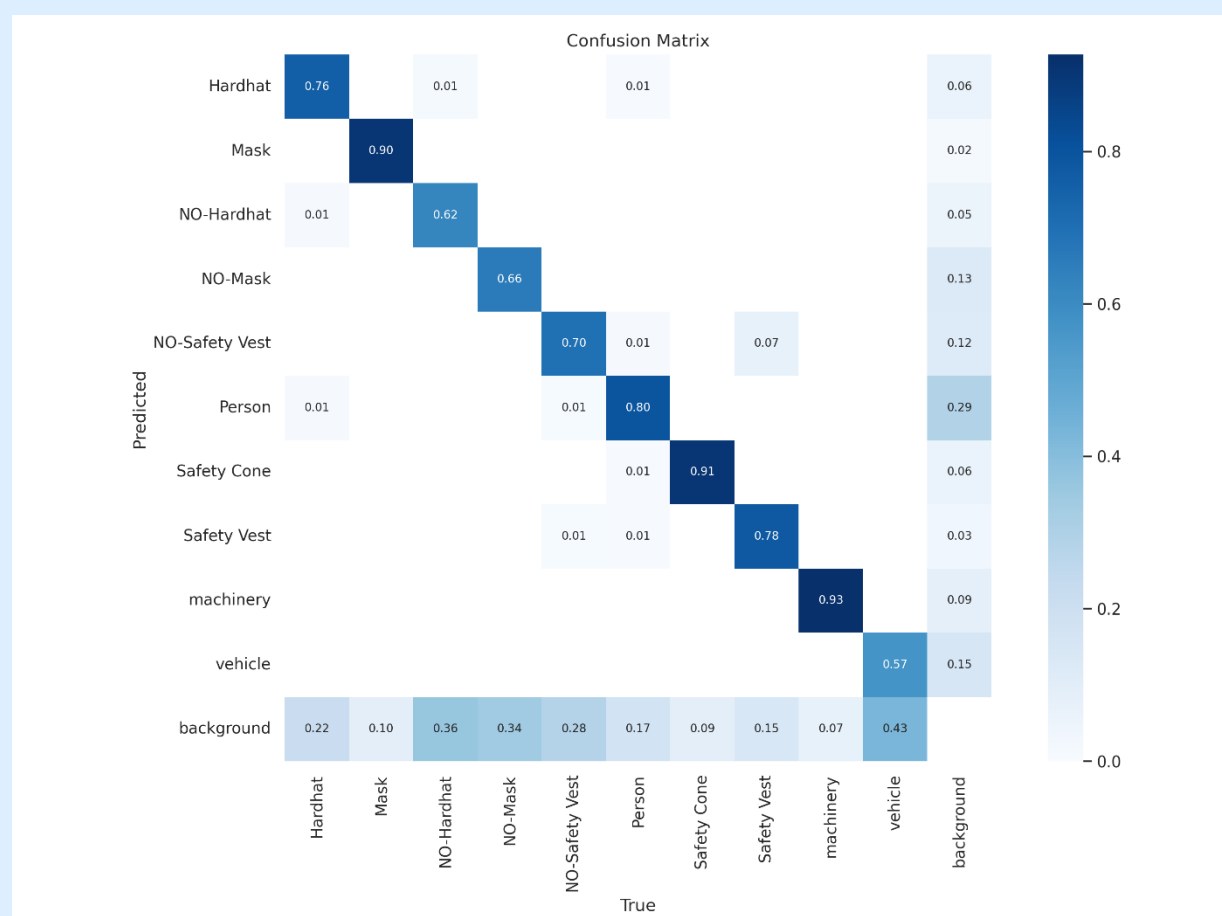
**Result Integration:** Results are integrated into a structured format and prepared for display and logging.



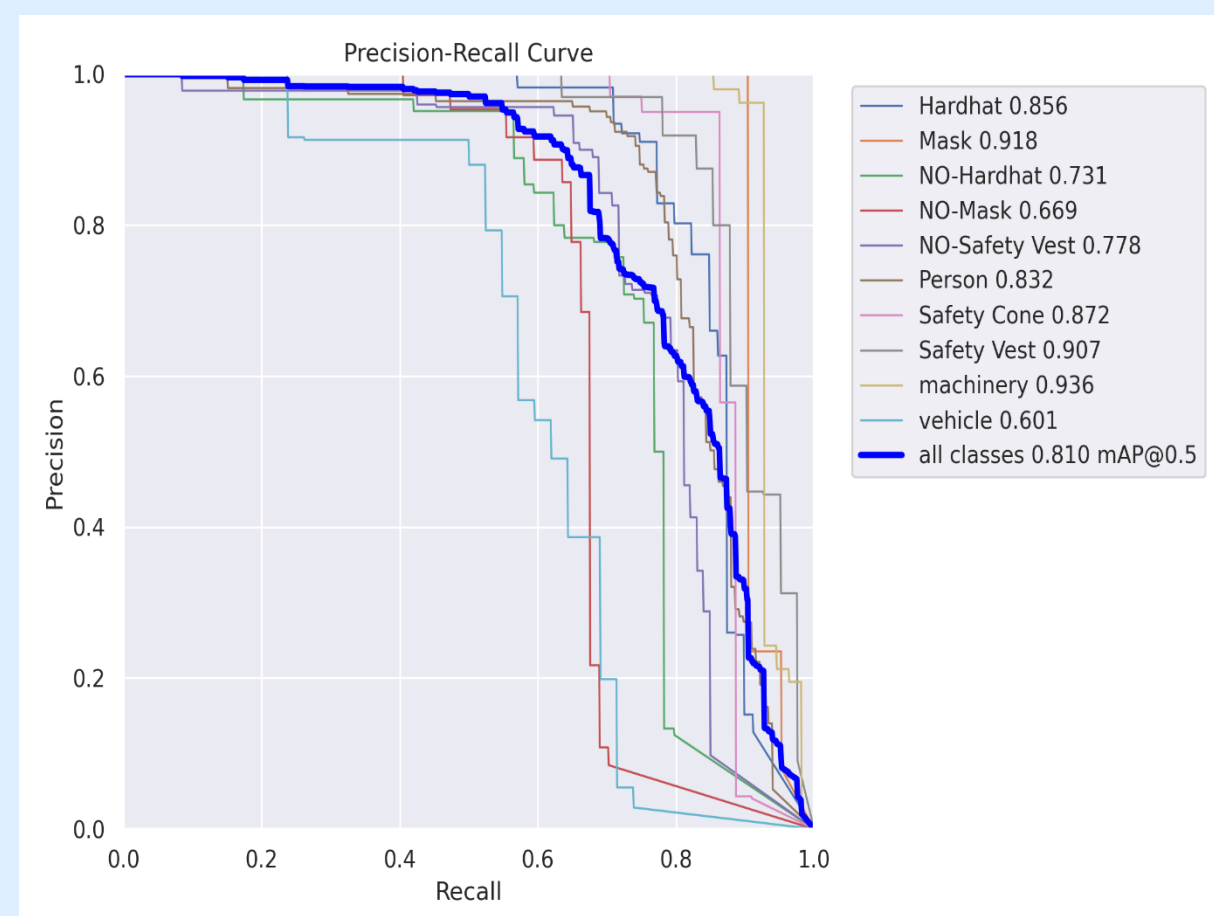
## Technologies Used



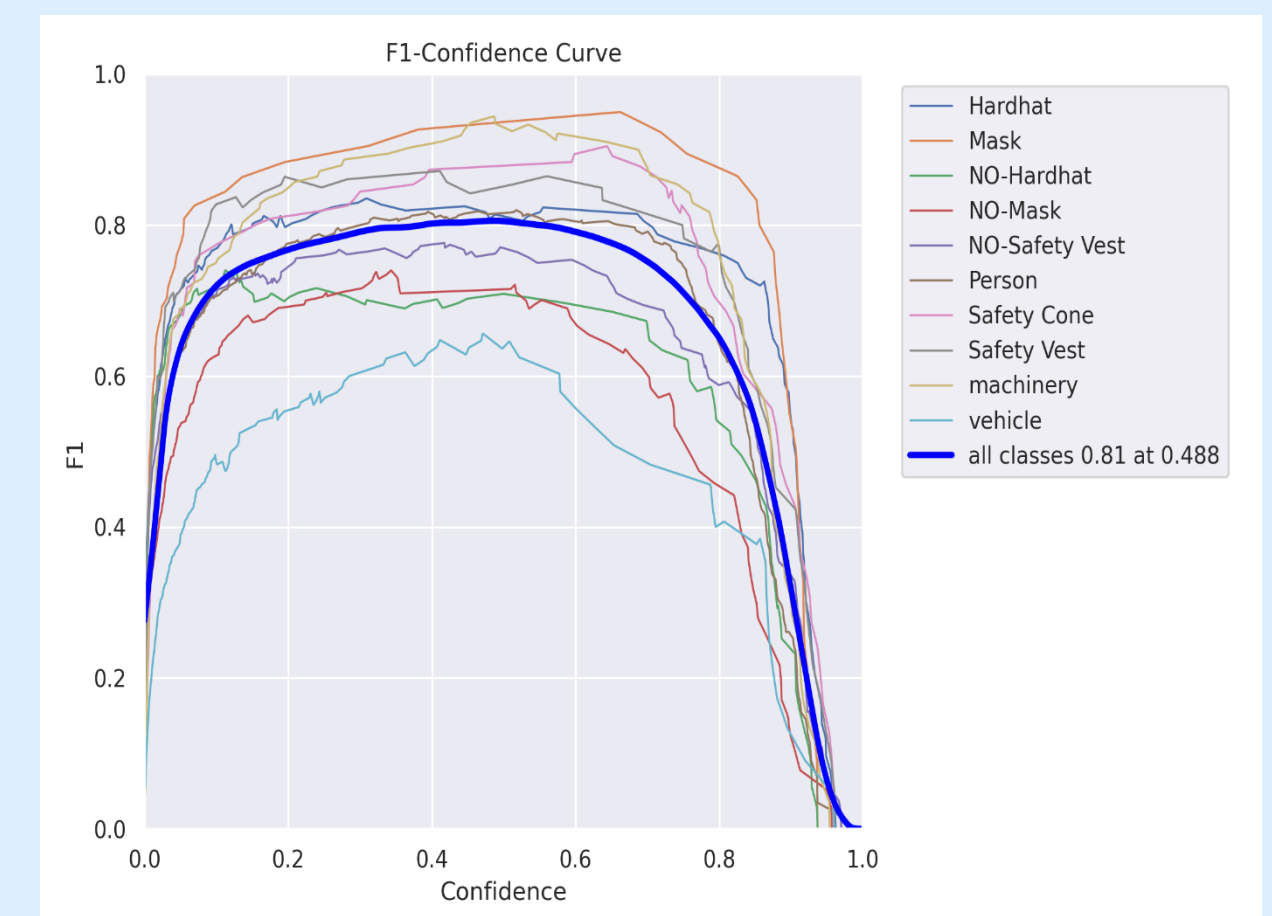
## Expected Results



The Confusion Matrix shows the classification performance, with diagonal elements representing correctly classified instances. Off-diagonal elements indicate misclassifications. High values along the diagonal indicate strong performance in correctly identifying classes.

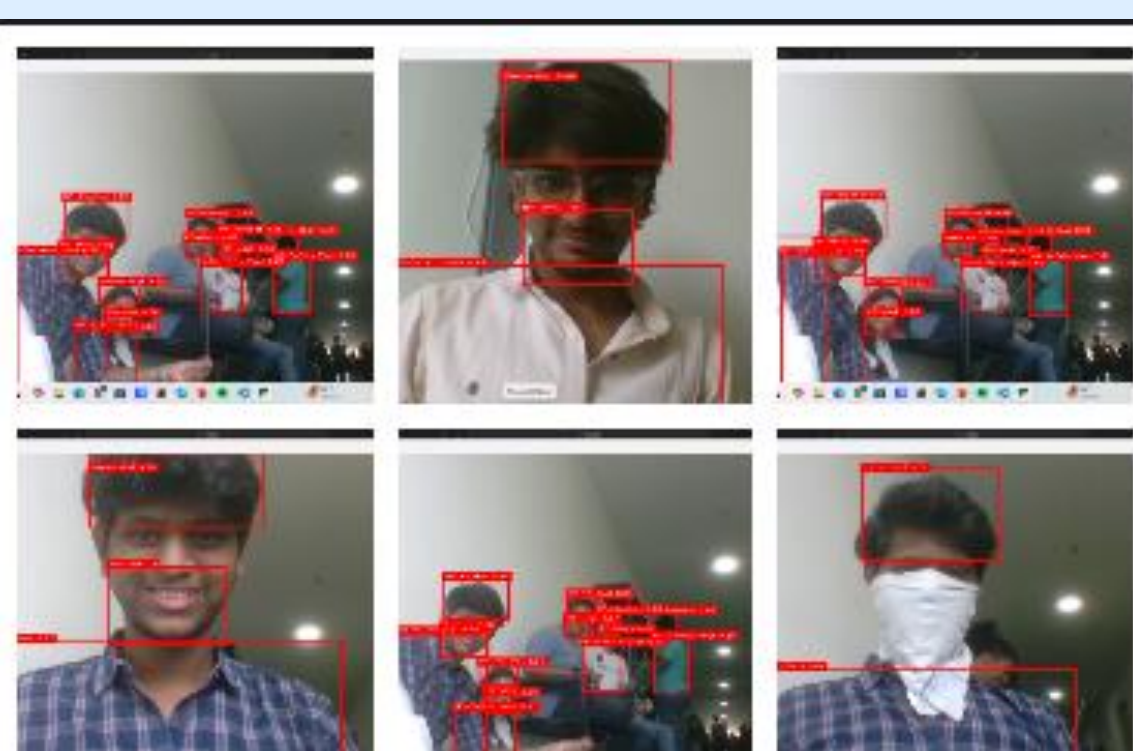


The Precision-Recall Curve illustrates the trade-off between precision and recall. A higher area under the curve indicates better performance, especially for imbalanced data where precision and recall are prioritized over accuracy.



The F1 Curve highlights the balance between precision and recall across different thresholds. The peak point indicates the best balance, where the model achieves the highest F1 score, ensuring an optimal trade-off between precision and recall.

## Outcomes



This project demonstrates real-time object detection for safety compliance in various environments. The model identifies essential safety gear, such as helmets, safety vests, and masks, providing confidence scores for each detection. This outcome highlights the system's ability to enhance workplace safety by accurately identifying individuals and their compliance with safety protocols in diverse settings.

## Bibliography/ References

- Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You Only Look Once: Unified, Real-Time Object Detection. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR).
- Bradski, G. (2000). The OpenCV Library. Dr. Dobb's Journal of Software Tools.
- Fang, Q., Li, L., Chen, L., Zhang, J., & Zhou, M. (2018). Real-Time Safety Helmet Detection Based on YOLOv2.
- Ghosh, S., Asefa, T., & Gadewar, A. (2020). AI-Based Construction Site Safety Management: A Review. Journal of Construction Engineering and Management.