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ANN&DL (AI253IA)

# WORKPLACE SAFETY THROUGH PPE DETECTION

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# INTRODUCTION

- Workplace safety is a fundamental concern in industries such as construction, manufacturing, oil and gas, and healthcare, where workers are exposed to hazardous environments.
- According to the International Labour Organization (ILO), more than 2.3 million workers die each year due to work-related accidents or diseases, while hundreds of millions suffer from non-fatal injuries.
- Many of these incidents are caused by non-compliance with safety regulations, particularly the failure to wear necessary personal protective equipment (PPE), such as helmets, gloves, safety vests, and face masks.

# LITERATURE REVIEW

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**Deep Learning-Based PPE Detection**

- M. Ahmed and et al. proposed a deep learning-based PPE detection system using YOLOv3 to identify helmets, vests, and gloves in real-time. The model was trained on a dataset containing construction site images and achieved an accuracy of 92.5%. The study highlighted the effectiveness of real-time object detection in improving workplace safety.
- L. Zhang and W. Li developed an improved Faster R-CNN model for detecting safety gear violations in industrial environments. The system demonstrated 89.8% accuracy in identifying helmets and safety jackets. Their approach incorporated data augmentation to improve model robustness under varying lighting conditions.
- K. Singh and R. Patel implemented a hybrid deep learning approach combining CNN and Support Vector Machines (SVM) for PPE detection. The proposed system classified PPE usage with 95.2% accuracy and was integrated with edge computing devices for real-time monitoring in hazardous areas.

# LITERATURE REVIEW

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**Computer Vision and PPE Recognition**

- H. Wang et al. utilized OpenPose and YOLOv4 to detect PPE compliance by analyzing human posture and safety gear. Their system could identify helmet use and harness attachment in high-altitude worksites, achieving a 91.3% detection accuracy.
- D. Sharma et al. introduced a multi-class object detection model using EfficientDet for PPE identification in factory environments. The study demonstrated that EfficientDet outperformed traditional CNN models, achieving a mean average precision (mAP) of 78.4% in detecting helmets, gloves, and vests.
- P. Kumar and M. Das investigated the use of a combination of background subtraction and deep learning for PPE detection. Their approach reduced false positives by 22%, making it more suitable for noisy industrial settings.

# LITERATURE REVIEW



**Real-Time PPE Monitoring and IoT Integration**

- A. Roy et al. integrated AI-based PPE detection with IoT-enabled cameras for real-time workplace monitoring. Their system used YOLOv5 to detect safety gear violations and automatically triggered alerts in case of non-compliance. The model achieved a 94.1% accuracy and reduced safety violations by 40% in experimental deployments.[8] S. Gupta et al. developed a real-time monitoring system combining facial recognition and PPE detection to ensure compliance in restricted areas. Their CNN-based model achieved 97.3% accuracy in distinguishing authorized personnel from non-compliant workers.

- J. Chen and X. Liu proposed a cloud-based PPE detection framework using MobileNetV2, allowing remote safety monitoring via mobile applications. The lightweight model achieved 90.2% accuracy while reducing inference time by 35% compared to traditional CNNs. Challenges in PPE Detection Systemsance model generalization.[11] R. Thompson et al. investigated dataset

# PROBLEM STATEMENT



Develop a real-time PPE detection system using YOLOv8 to enhance workplace safety. The system aims to identify safety gear such as helmets, gloves, vests, and masks in industrial settings, assisting safety officers in ensuring compliance. By leveraging deep learning and computer vision, the system provides accurate, accessible, and scalable solutions for real-time PPE monitoring.

# DATA STRATEGY

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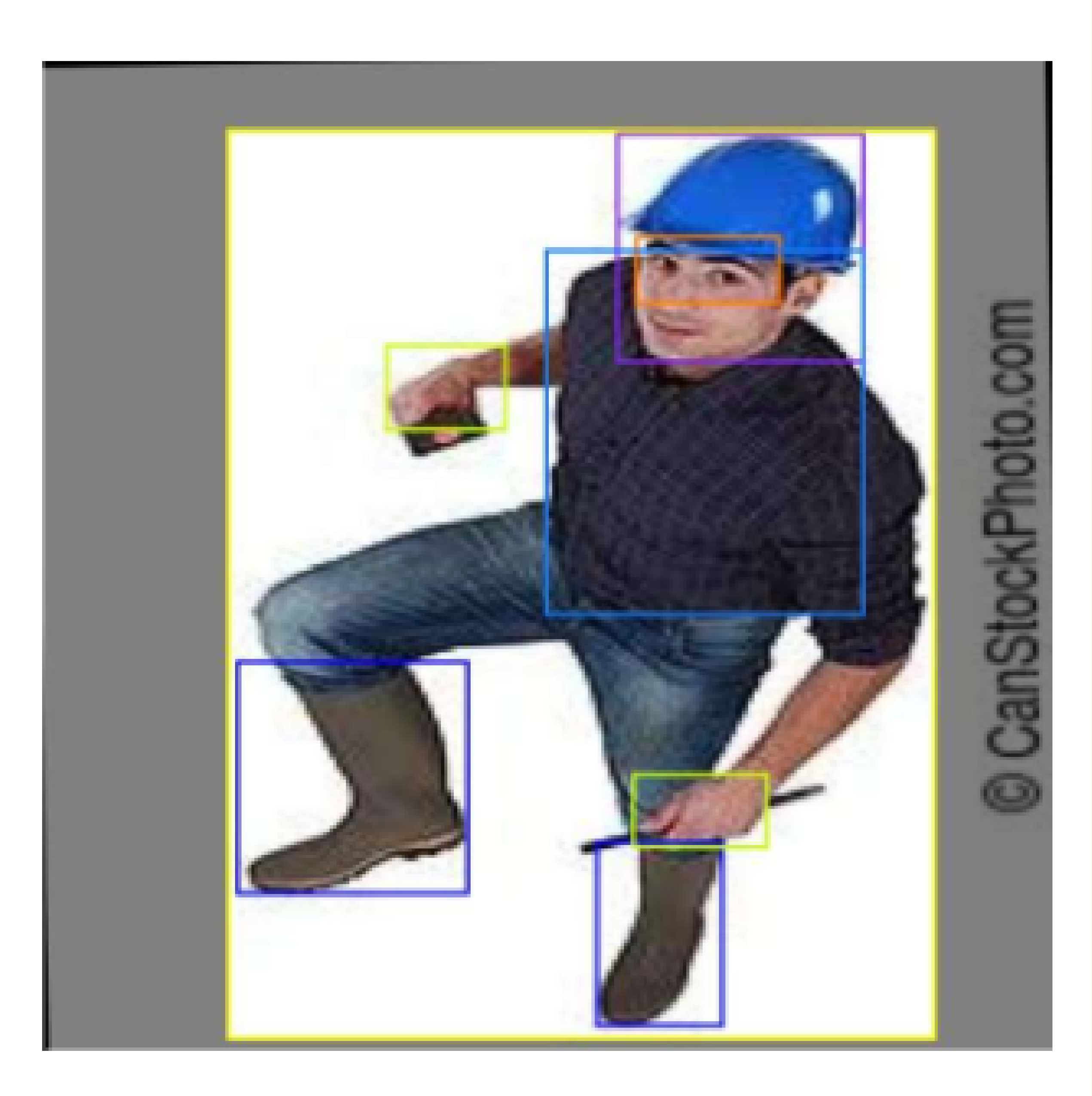
The dataset consists of labeled images and videos of workers in industrial settings. PPE categories include:

- Helmets
- Safety Vests
- Gloves
- Goggles
- Non-PPE instances (for detecting violations)

| PPE Type | Number of Images |
|---|---|
| Helmets | 3426 |
| Safety Vests | 2305 |
| Gloves | 1705 |
| Goggles | 1009 |
| Masks | 1935 |
| Non-PPE Cases | 4356 |
| Total Images | 8963 |



# MODEL ARCHITECTURE

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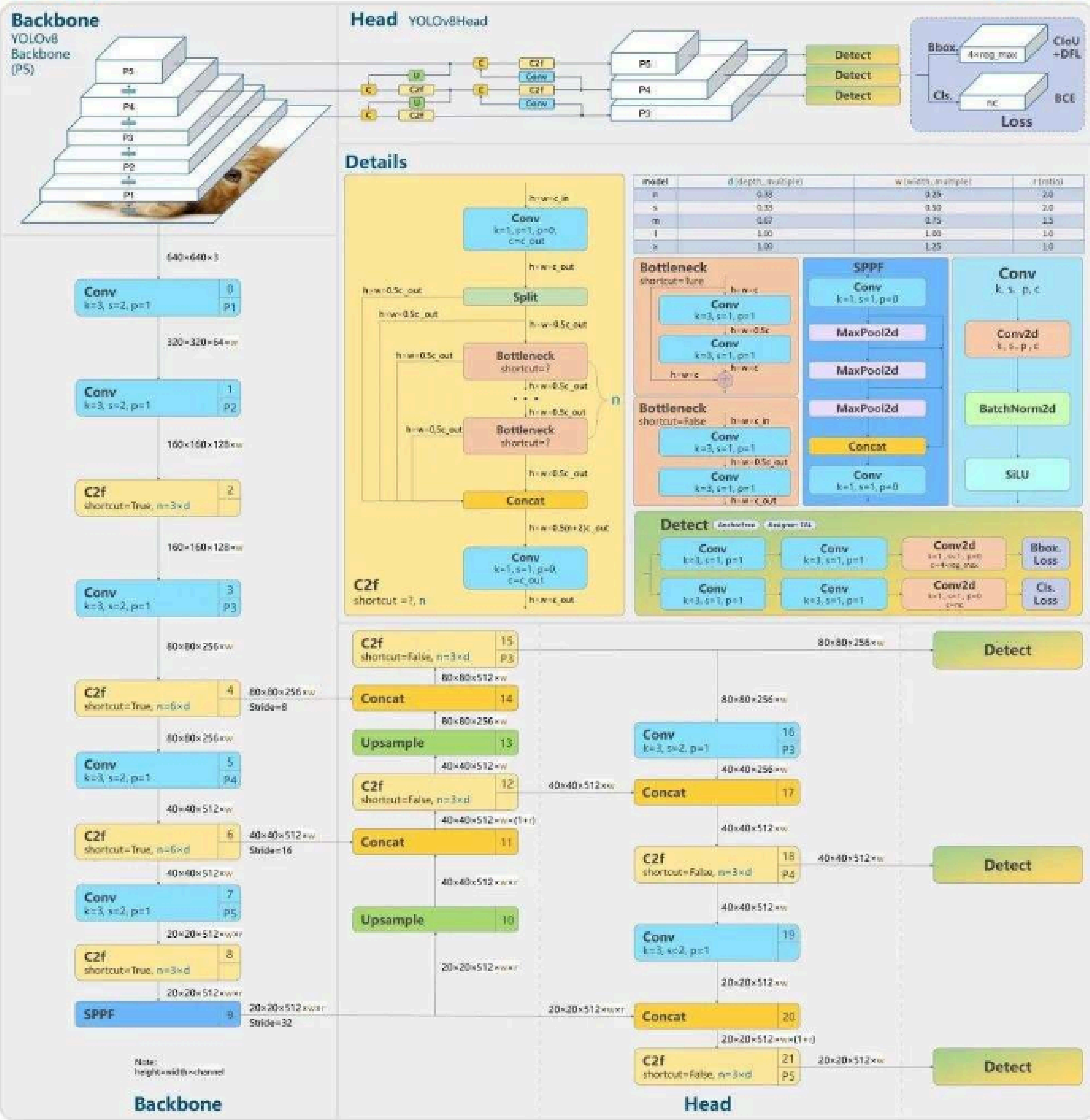
YOLOv8 stands out due to its exceptional balance of accuracy and speed, making it ideal for real-time applications. It features a lightweight architecture, improved accuracy with anchor-free detection, and supports not only object detection but also image segmentation and classification. Its user-friendly integration, efficient training capabilities, and versatility across tasks make YOLOv8 a strong choice over other models, especially for edge devices and real-time use cases.



# WORKFLOW

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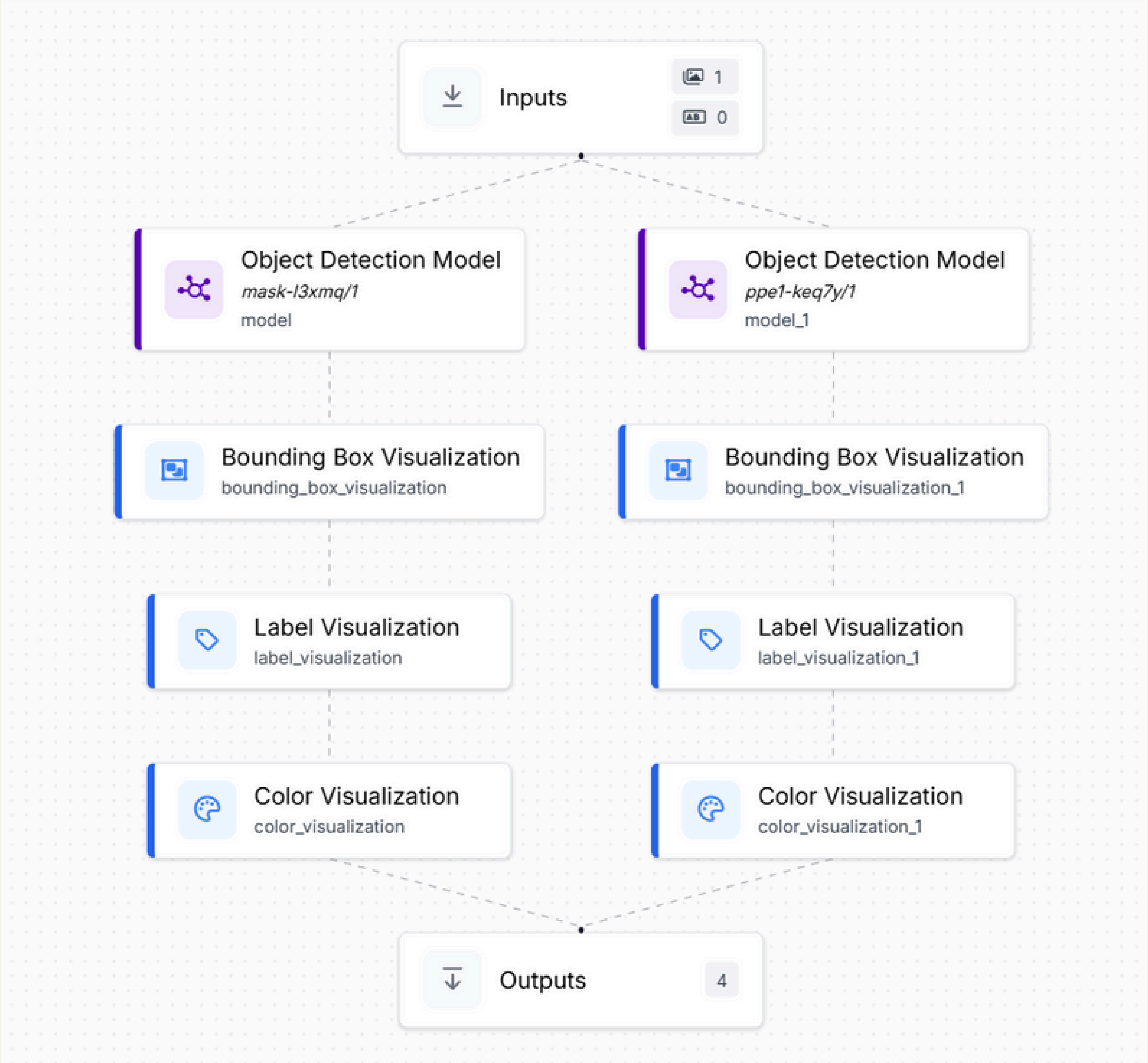
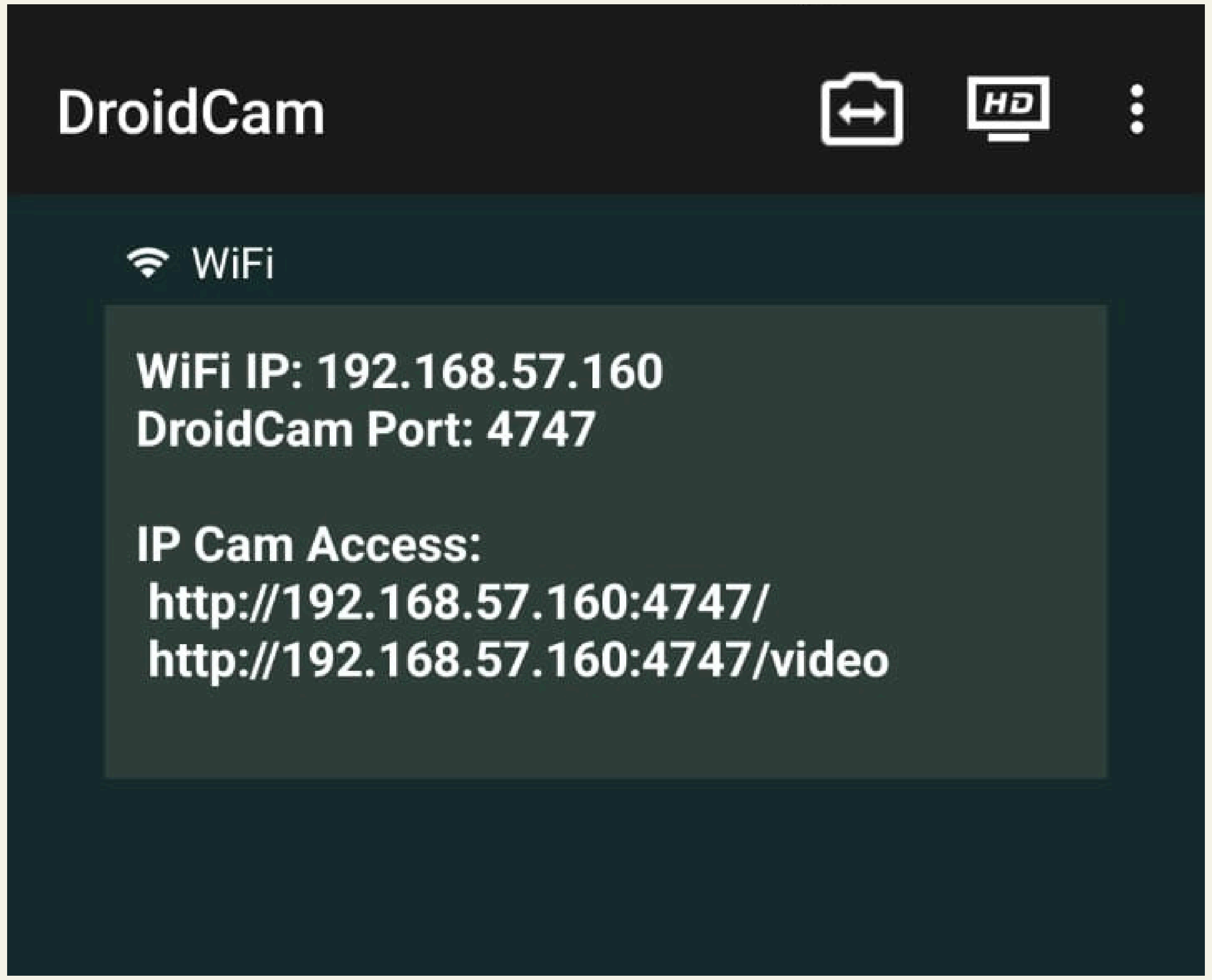



workflow




Droid Cam

# RESULTS

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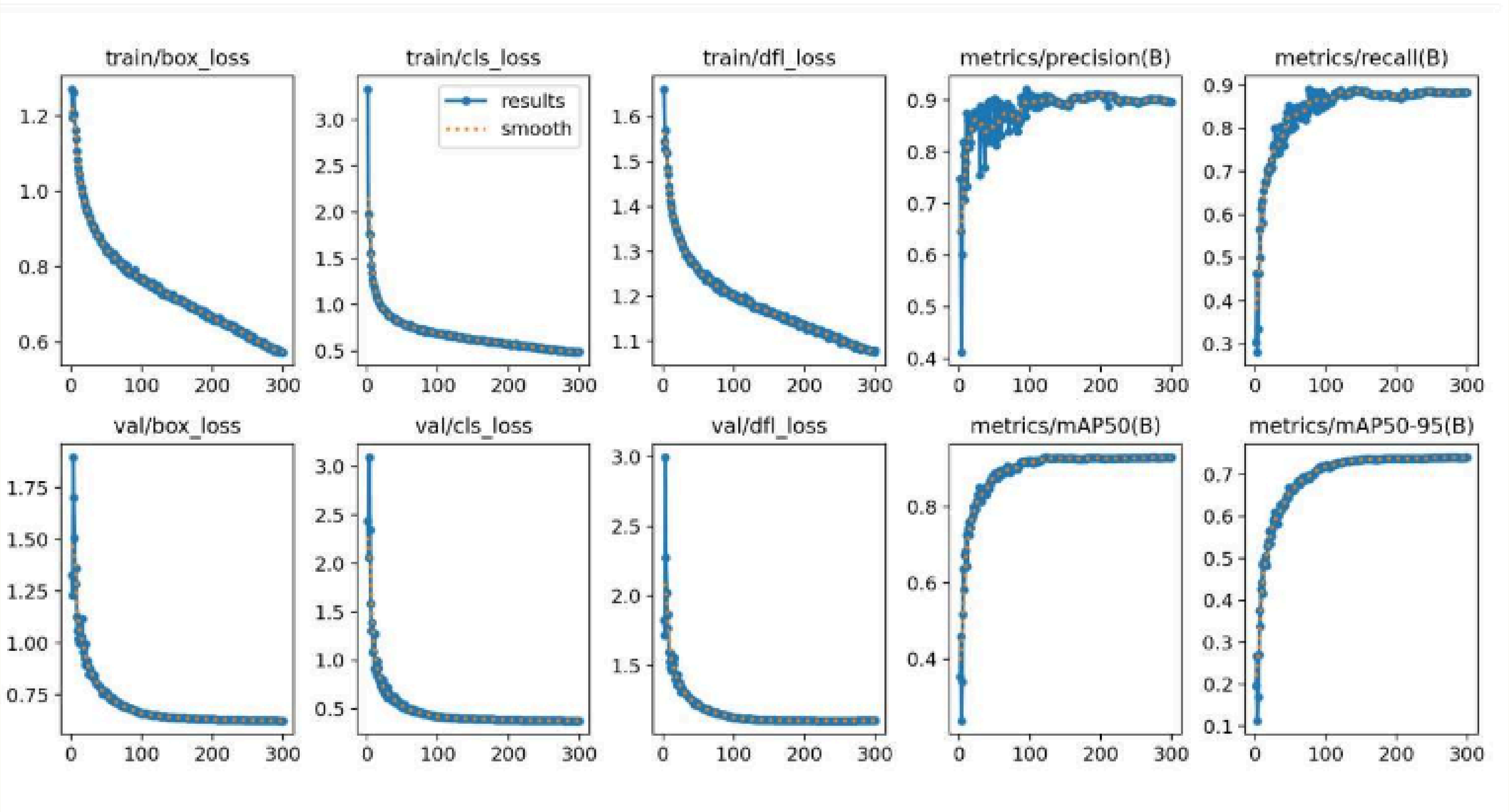


- The above is a visual representation of the change in model metrics with each epoch. As we run epochs, we see three discrete values in all the different metrics. It’s clear that the model’s performance improves drastically from the first epoch evidenced by the change in all three metrics

# RESULTS

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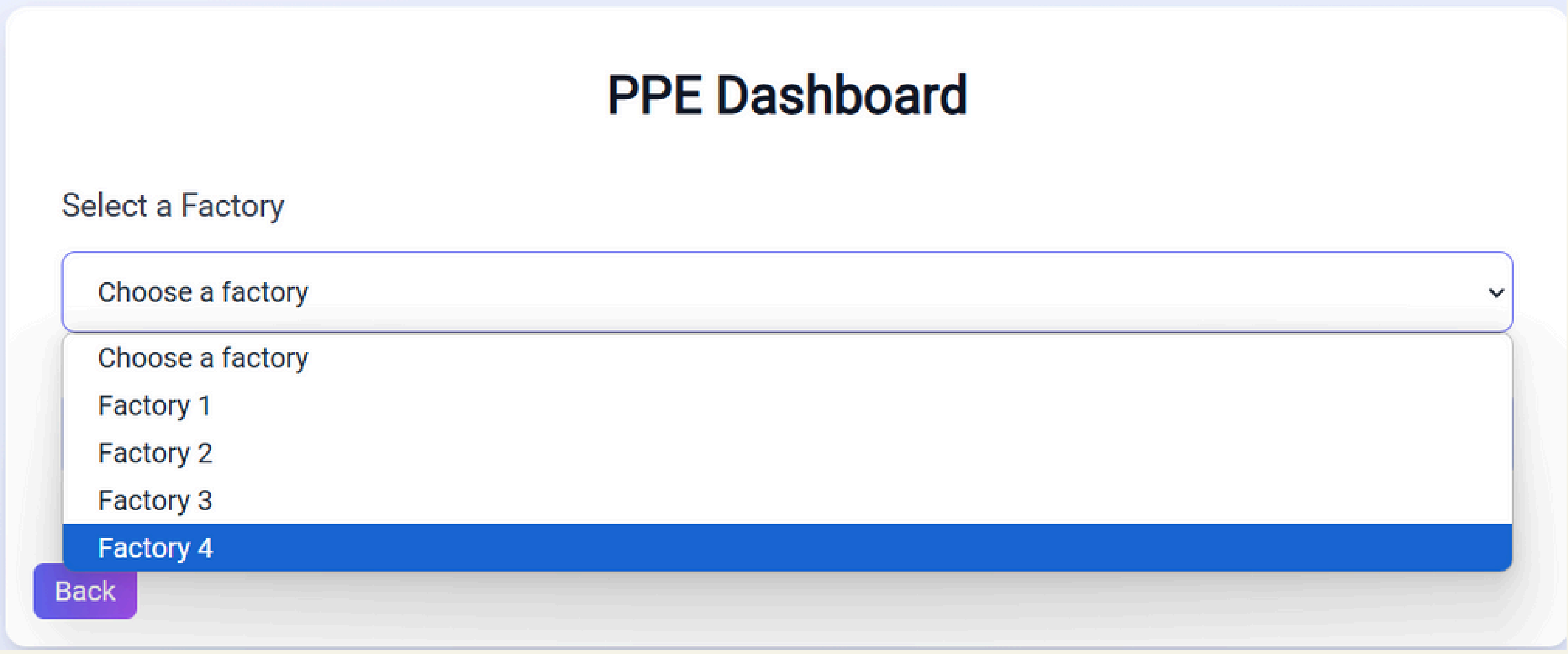
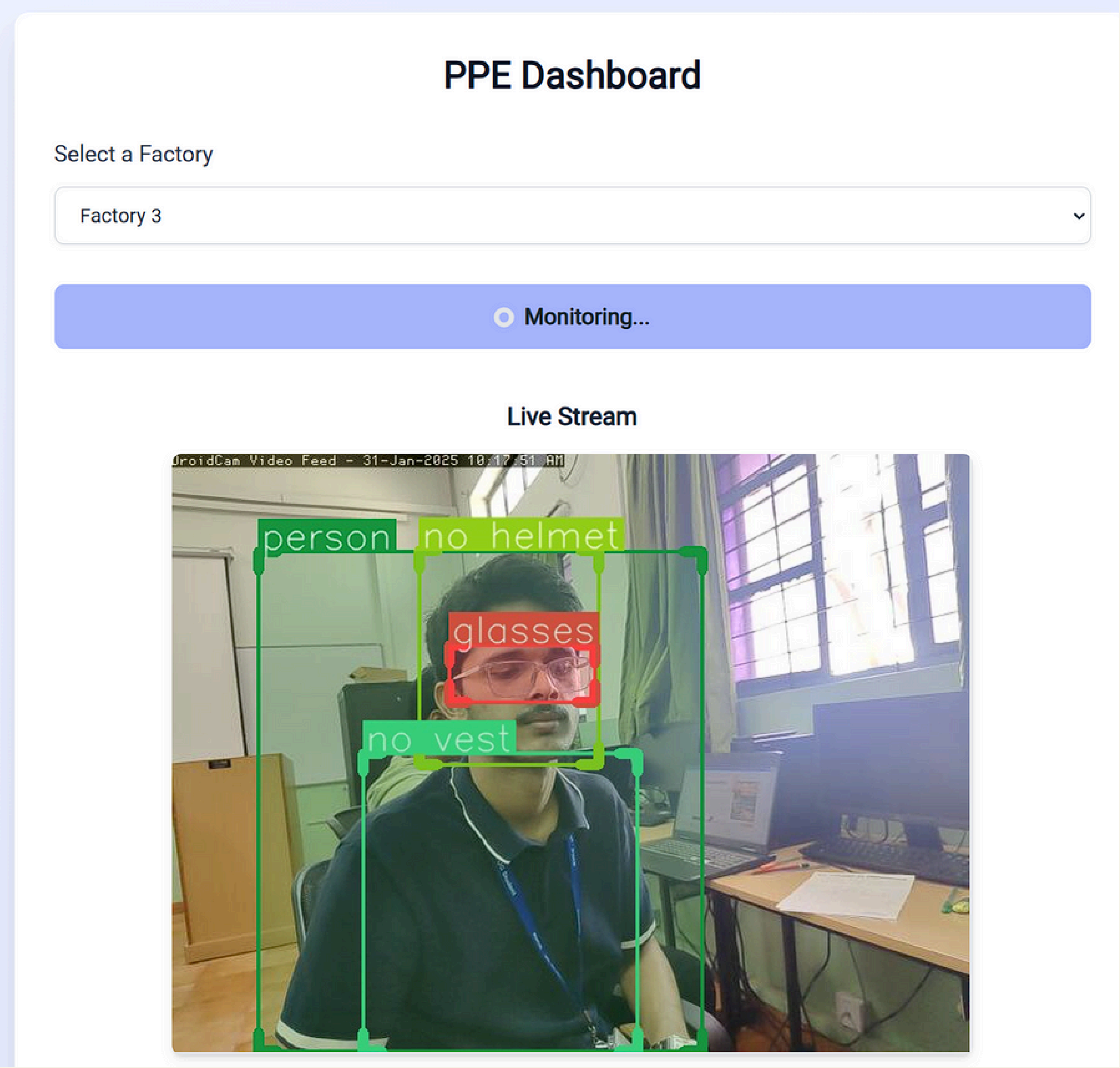
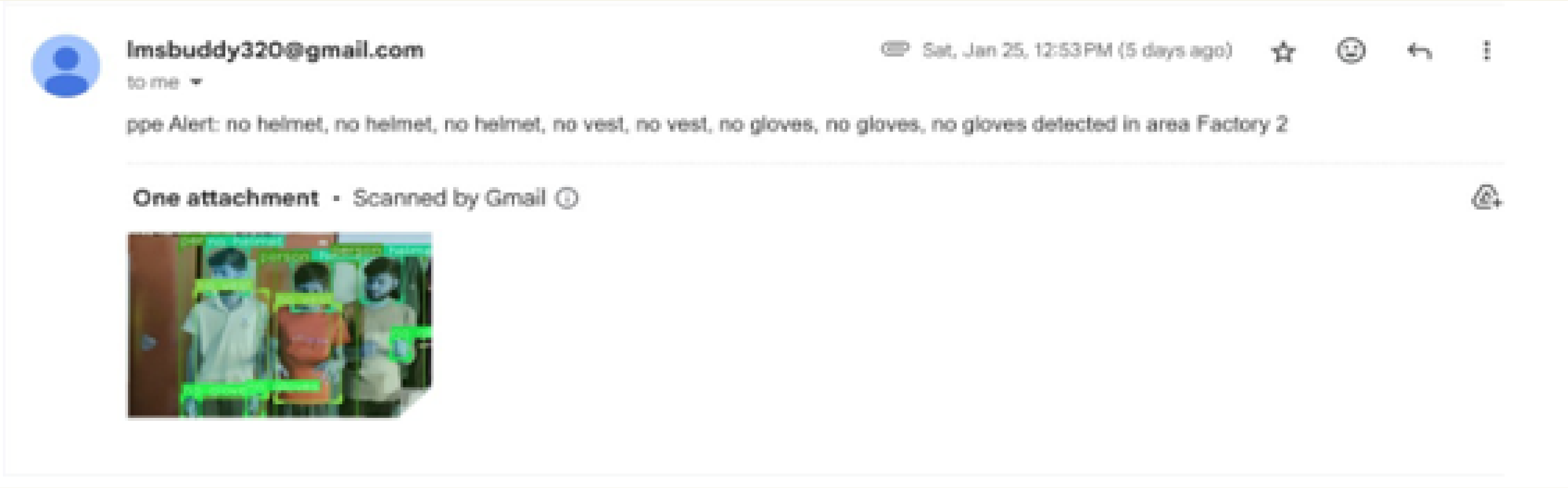



- The dashboard provides the option to choose the different factory and its cameras(RTSM based video streaming). Upon choosing the camera, camera provides live feed and it is sent to the model.

# RESULTS






- Here the webpage displays a section where the video is streamed using RTSP(DroidCam). The streamed video is sent to the model workflow and the detection is done. The results are displayed with suitable color, label and bounding boxes. SMTP sends the alert in case of no ppe detection.

# CONCLUSION

- The Workplace Safety through PPE Detection project demonstrates the power of deep learning and computer vision in ensuring workplace compliance and worker safety. By leveraging the YOLOv8 model, the system effectively detects the presence or absence of personal protective equipment (PPE) such as helmets, gloves, vests, and masks in real time. The model achieves high accuracy and fast inference speed, making it suitable for real-world industrial applications.
- This project successfully meets its objective of improving workplace safety through automated PPE detection. By reducing the need for manual inspections and ensuring compliance with safety regulations the system helps mitigate workplace hazards, prevent injuries, and promote a safer work environment

# THANK YOU