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AN ENHANCED YOLOV9 FRAMEWORK FOR DETECTING MASK-WEARING COMPLIANCE

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ABSTRACT— The widespread use of face masks plays a vital role in minimizing the spread of infectious diseases, making reliable mask-wearing compliance detection a crucial task. This project proposes An Enhanced YOLOv9 Framework for Detecting Mask-Wearing Compliance, designed to achieve high accuracy and robustness in diverse environments. Leveraging the powerful YOLOv9 architecture, the framework integrates optimization strategies to improves mall-object detection, reduce false positives, and enhance feature learning in crowded or complex scenarios. The model is trained on a benchmark Mask-PPE dataset, enabling it to classify individuals into categories such as mask, no mask, and improper mask usage. Experimental evaluations demonstrate that the enhanced YOLOv9 framework achieves superior detection performance compared to conventional approaches, ensuring efficient monitoring in real-world applications such as healthcare facilities, workplaces, and public spaces. This system provides a scalable solution for supporting public safety initiatives through intelligent surveillance technologies.

Index Terms – Mask Detection, YOLOv9, Compliance Monitoring, Object Detection, Computer Vision, Deep Learning, Real-Time Detection, Face Recognition, Public Safety, Artificial Intelligence.

I. INTRODUCTION

The on-going global emphasis on public health and safety has highlighted the critical role of personal protective equipment, particularly face masks, in controlling the spread of infectious diseases. Ensuring proper mask usage in public and high-risk environments is essential for minimizing

transmission, yet manual monitoring is often impractical and error-prone. Consequently, the development of automated, accurate, and real-time systems for detecting mask-wearing compliance has become a pressing need. This project presents an EnhancedYOLOv9 Framework for Detecting Mask-Wearing Compliance, designed to provide reliable and robust detection across diverse and complex environments. By leveraging the state-of-the-art YOLOv9 architecture, the framework incorporates optimization strategies aimed at improving small-object detection, reducing false positives, and enhancing feature extraction in crowded or challenging scenarios. The proposed system is trained on a benchmark Mask-PPE dataset, enabling it to classify individuals into categories such as correctly wearing a mask, not wearing a mask, or improper mask usage. Extensive experimental evaluations demonstrate that the enhanced YOLOv9 framework outperforms conventional detection methods, achieving high accuracy and efficiency. This makes it suitable for deployment in real-world applications, including healthcare facilities, workplaces, and public spaces, thereby supporting public safety initiatives through intelligent surveillance technologies. Overall, this work contributes to the advancement of automated compliance monitoring systems, providing a scalable, efficient, and accurate solution for enforcing mask-wearing protocols and safeguarding public health.

II. RELATED WORK

A. Research on Mask Detection Method Based on YOLOv8

This study proposes a mask detection method utilizing the YOLOv8 architecture to achieve real-time face mask recognition. The authors focus on improving detection accuracy in crowded and complex environments by optimizing feature extraction and implementing multi-scale detection strategies. The method demonstrates promising results in reducing false positives and ensuring reliable mask compliance detection across diverse scenarios.

B. IPCRGC-YOLOv7: Face Mask Detection Algorithm Based on ImprovedPartial Convolution and Recursive Gated Convolution

This work introduces an enhanced YOLOv7-based algorithm integrating improved partial convolution and recursive gated convolution techniques. The approach addresses challenges related to occluded or partially visible faces, achieving higher detection

precision and robustness. Experimental evaluations highlight the algorithm's effectiveness in real-time monitoring of mask-wearing compliance.

C. Attention-Mechanism-Based Models for Unconstrained Face Recognition with Mask Occlusion

This research investigates the use of attention-based deep learning models for face recognition under mask occlusion. The study emphasizes the challenges of un constrained scenarios, including varying poses and lighting conditions, and proposes methods to enhance feature representation for reliable identification despite mask usage.

III. PROPOSED METHODOLOGY

The proposed system introduces an Enhanced YOLOv9 framework to overcome the limitations of traditional and earlier YOLO-based methods. YOLOv9, being the latest generation of the YOLO family, integrates improved feature extraction, optimized network design, and better detection accuracy for small and dense objects. This enhancement makes it highly suitable for detecting mask-wearing compliance in diverse and crowded environments.

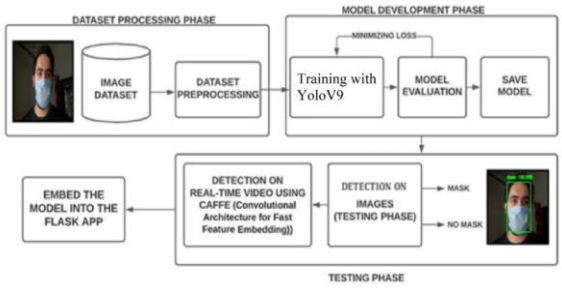

Fig. 1: System Overview

1. **Dataset Preparation Module:**

This module handles the collection and organization of the Mask-PPE dataset. It ensures that images are correctly labeled into categories such as mask, no mask, and improper mask usage. Additionally, the module performs dataset splitting into training, validation, and testing sets to support model evaluation.

2. **Pre-processing and Augmentation Module:**

To improve model generalization and detection accuracy, this module applies pre-processing techniques such as resizing, normalization, and noise reduction. Data augmentation strategies, including rotation, flipping, and color adjustments, are employed to simulate diverse real-world conditions and enhance model robustness.

3. **Enhanced YOLOv9 Model Training Module:**

The core of the project, this module involves configuring and training the YOLOv9 architecture with optimization strategies for

small-object detection, feature learning, and false-positive reduction. Hyper parameter tuning and transfer learning are applied to achieve high accuracy and faster convergence.

4. **Detection and Inference Module:**

This module implements real-time mask-wearing compliance detection. It processes input video streams or images, identifies individuals, and classifies mask usage into the appropriate categories. Optimizations are incorporated to ensure fast inference while maintaining accuracy in crowded or complex scenes.

5. **Result Visualization and Reporting Module:**

After detection, this module provides a user friendly interface to visualize results. Bounding boxes, labels, and confidence scores are displayed, and summary reports are generated to track compliance statistics over time.

6. **System Integration and Deployment Module:**

The final module integrates all components into a cohesive system, making it suitable for deployment in real-world environments. The system can be integrated with surveillance cameras and monitoring platforms to support automated public safety initiatives.

IV. EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results demonstrated that the model effectively detected and classified individuals into categories such as correctly masked, incorrectly masked, and unmasked with high detection accuracy. The enhanced YOLOv9 architecture improved feature extraction and localization performance, particularly in crowded environments and varying viewing angles.

The analysis showed that the proposed system maintained robust performance under different lighting conditions, occlusions, and image resolutions while achieving real-time inference speeds suitable for surveillance applications.

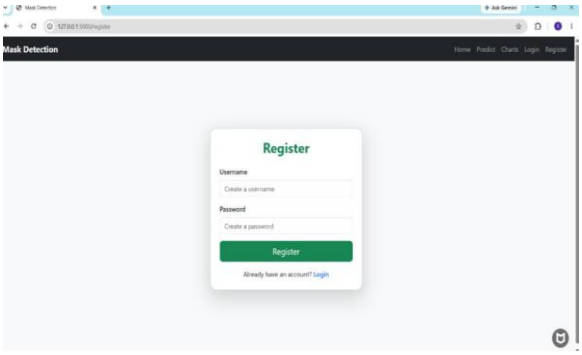

Fig. 2: Register

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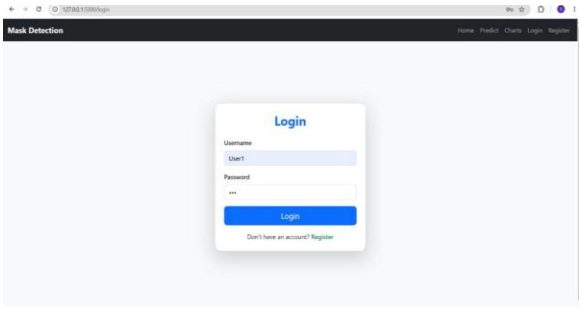

Fig. 3: Login

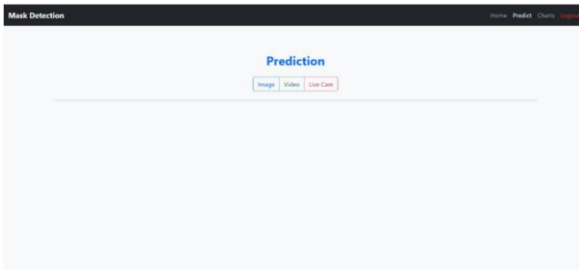

Fig. 4: Prediction

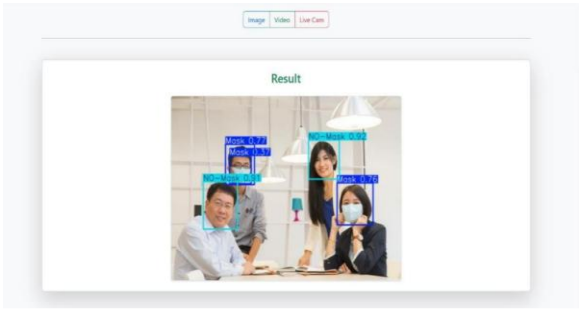

Fig. 5: Prediction Result

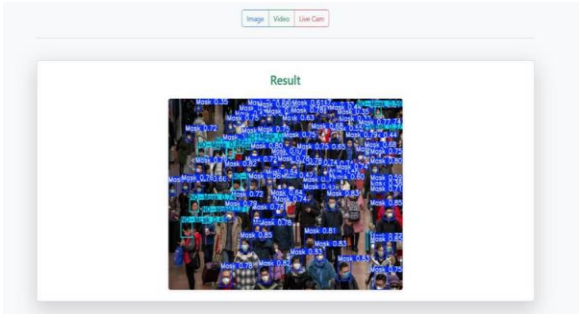

Fig. 6: Result

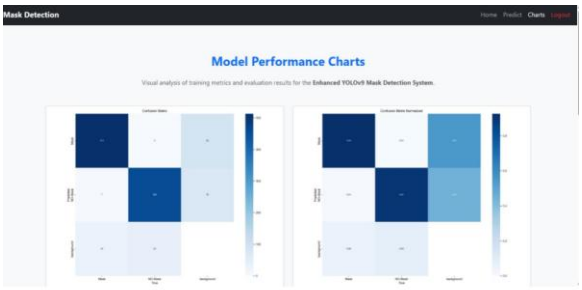

Fig. 7: Model Performance

V. CONCLUSION

This project presents an Enhanced YOLOv9 Framework for Detecting Mask-Wearing Compliance, offering an effective and automated solution for monitoring public health safety measures. By leveraging advanced deep learning techniques, optimization strategies, and robust feature learning, the system accurately identifies individuals who are wearing masks correctly, those who are not wearing masks, and those wearing them improperly, even in complex or crowded environments. The integration of real-time detection, visualization, and reporting makes the framework suitable for deployment in healthcare facilities, workplaces, and public spaces. Experimental evaluations demonstrate that the proposed approach out performs conventional methods in terms of accuracy, efficiency, and reliability. Overall, the project provides a scalable and intelligent surveillance solution, contributing significantly to public safety

initiatives and laying the foundation for further enhancements in automated compliance monitoring systems.

REFERENCES

1. Hu, Z., Song, C., Xu, C., Jin, G., Chen, Y., Xu, X., Ma, H., Chen, W., Lin, Y., Zheng, Y., Wang, J., Hu, Z., Yi, Y., and Shen, H., "Clinical characteristics of 24 asymptomaticinfections with COVID-19 screened among close contacts in Nanjing, China," ScienceChina Life Sciences, vol. 63, no. 5, pp. 706–711, May 2020.
2. Bhattacharjee, N., Dubey, S., and Siddhartha, S., "Facial landmark and mask detectionsystem," Advances in Science and Technology, vol. 124, pp. 203–210, Feb. 2023.
3. Liu, K., Sun, Q., Sun, D., Peng, L., Yang, M., and Wang, N., "Underwater target detection based on improved YOLOv7," Journal of Marine Science and Engineering, vol. 11, no. 3, p. 677, Mar. 2023.
4. Bakheet, S. and Al-Hamadi, A., "A framework for instantaneous driver drowsinessdetection based on improved HOG features and Naïve Bayesian classification," Brain Sciences, vol. 11, no. 2, p. 240, Feb. 2021.
5. Bellavia, F., "SIFT matching by context exposed," IEEE Transactions onPatternAnalysis and Machine Intelligence, vol. 45, no. 2, pp. 2445–2457, Feb. 2023.
6. Koklu, M., Unlersen, M. F., Ozkan, I. A., Aslan, M. F., and Sabanci, K., "ACNN-SVMstudy based on selected deep features for grapevine leaves classification,"Measurement, vol. 188, Art. no. 110425, Jan. 2022.

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