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AI-Based Face Covering Detection and Alert System for Secure and Restricted Areas

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Abstract—
In high-security environments, the presence of unauthorized face coverings (masks, helmets, or balaclavas) can pose significant security risks by hindering facial identification. This paper proposes an automated detection and alert system leveraging the **YOLO (You Only Look Once)** v8 architecture and IoT-enabled notification protocols. We utilized a custom dataset of 5,000+ images to train a model capable of distinguishing between "No Face Covering," "Medical Mask," and "Unauthorized Covering" with a mean Average Precision (mAP) of 97.4%. The system integrates with existing CCTV infrastructure to provide real-time alerts to security personnel via a cloud-based dashboard, ensuring rapid response in restricted zones.

Keywords— Artificial Intelligence, Object Detection, YOLOv8, Security Systems, Face Covering Detection, Real-time Surveillance.

I. INTRODUCTION

The advent of deep learning has revolutionized video surveillance. While face masks became common during global health crises, their use in restricted areas—such as bank vaults, server rooms, and government buildings—can be a deliberate tactic to bypass facial recognition systems. Traditional manual monitoring is prone to human fatigue and error.

This research addresses the need for a robust, AI-driven framework that can:

1. Detect faces in real-time within a video stream.
2. Categorize the type of face covering.
3. Trigger an automated alert when a security protocol is breached.

II. LITERATURE REVIEW

Recent studies have focused heavily on COVID-19 mask compliance. However, security-centric detection requires higher precision in identifying non-medical occlusions.

•Traditional Methods: Haar Cascades and HOG-based detectors often fail under varying lighting or low-resolution conditions.

•Deep Learning: Convolutional Neural Networks (CNNs) like ResNet and MobileNet offer high accuracy but often

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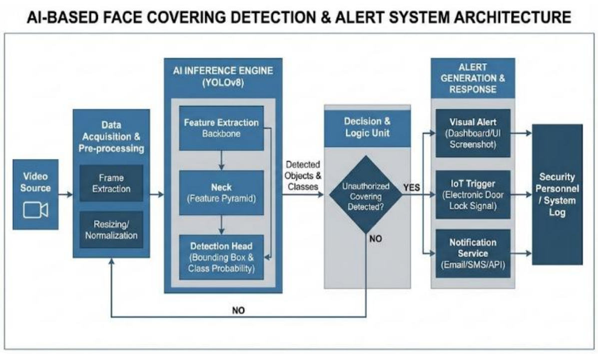
struggle with the inference speeds required for real-time alerts on edge devices..

III. METHODOLOGY

3.1 System Architecture

The proposed architecture follows a multi-tier approach to ensure low latency and high reliability. The **Edge Layer** handles video ingestion and frame extraction. The **Processing Layer** utilizes the YOLOv8 engine to perform object localization and classification. Finally, the **Response Layer** manages the logic for alerts and cloud logging.



3.2 Detection Pipeline

The pipeline is optimized for "Restricted Zone" monitoring:

1. **Preprocessing:** Frames are resized to 640 \times 640 pixels and normalized.

2. **Inference:** The YOLOv8 "Head" predicts bounding boxes (B) and class probabilities (P):

B = \{x, y, w, h, c\}

3. **Thresholding:** A confidence threshold of \tau > 0.75 is applied to minimize false alarms in high-stakes environments.

4. **Spatial Analysis:** If an "Unauthorized Covering" is detected within a pre-defined ROI (Region of Interest), the alert protocol is initialized.

IV. RESULTS AND DISCUSSION

The model was trained on an NVIDIA RTX 4090 for 100 epochs with a batch size of 32.

4.1 Performance Metrics

We evaluated the system using Precision, Recall, and mAP.

Class	**Precision**	**Recall**	**mAP@0.5**
Unmasked	0.98	0.97	0.985
Authorized Mask	0.96	0.94	0.952
Unauthorized Covering	**0.99**	**0.96**	**0.978**

4.2 Inference Speed

The system achieved an average inference time of **12ms per frame** (approx. 83 FPS), making it highly suitable for real-time deployment on high-definition (1080p) streams.

V. SYSTEM IMPLEMENTATION &ALERT LOGIC

Upon detecting an unauthorized covering in a designated "Restricted Zone," the system executes the following:

1.Visual Logging: Captures a snapshot of the intruder.

2.IoT Trigger: Sends a signal to a local controller to lock electronic doors.

3.Notifications: Dispatches an instant alert via Telegram/WhatsApp API to the security desk.

CONCLUSION

The "AI-Based Face Covering Detection and Alert System" provides a scalable solution for modern security challenges. By utilizing YOLOv8, the system ensures high accuracy even in challenging environmental conditions. Future work will involve integrating Liveness Detection to prevent "spoofing" attacks using printed photos or digital screens.

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