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VISION VAULT: INTELLIGENT VIDEO SURVEILLANCE SYSTEM

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Abstract—**Vision Vault: Intelligent Video Surveillance System is a cutting-edge solution designed to enhance security in office environments through real-time object detection and analysis using the YOLO v8 algorithm. The system integrates multiple advanced modules, including Video Acquisition for capturing live feeds, preprocessing for frame enhancement and formatting, and Object Detection for identifying and classifying objects. The Behaviour Analysis & Anomaly Detection Module monitors movements and detects suspicious activities, and unattended objects. When anomalies are detected, the Alert & Notification Module sends real time alerts via email, ensuring swift responses to potential threats. A user-friendly User Interface & Monitoring Module provides a dashboard for realtime monitoring, allowing security personnel to manage and review surveillance data efficiently. The system's modular and scalable architecture ensures adaptability to various office environments, making it a robust and fault-tolerant solution. By automating surveillance tasks and delivering actionable insights, Vision Vault enhances security, reduces manual effort, and optimizes office operations, ensuring a smarter and safer workplace.**

Keywords—**Intelligent Video Surveillance, Anomaly Detection, Office Surveillance, Anomaly Detection, Face Recognition, Occupancy Detection, Real-time alerts, Behaviour Analysis.**

I.INTRODUCTION

In an era where security threats are becoming increasingly sophisticated, the need for advanced surveillance systems has never been more critical. Traditional surveillance methods, which rely heavily on manual monitoring, are often inefficient, prone to human error, and unable to provide real-time threat detection. These limitations highlight the necessity for intelligent, automated solutions that can proactively identify and respond to security breaches. This project, titled Vision Vault: Intelligent Video Surveillance System, aims to address these challenges by leveraging cutting-edge technologies such as deep learning and computer vision to create a robust, real-time surveillance solution.

The system is designed to enhance security in office environments, public spaces, and restricted access zones by automating the detection of suspicious activities, unauthorized access, and potential threats. By integrating advanced features like object detection, motion tracking, and facial recognition, the system not only improves security but also provides valuable insights into crowd management, space utilization, and behavioral analytics. This makes it a versatile tool for organizations looking to optimize their operations while ensuring a safe environment.

At the core of this system lies the YOLO v8 (You Only Look Once) algorithm, a state-of-the-art deep learning model known for its speed and accuracy in real-time object detection. This allows the system to process video feeds instantaneously, identifying and classifying objects such as humans, vehicles, and other entities with high precision. Additionally, the system is designed to be modular and scalable, making it adaptable to various organizational needs and environments.

By automating surveillance tasks and reducing reliance on manual monitoring, Vision Vault not only enhances security but also improves operational efficiency, making it a vital tool for modern organizations.

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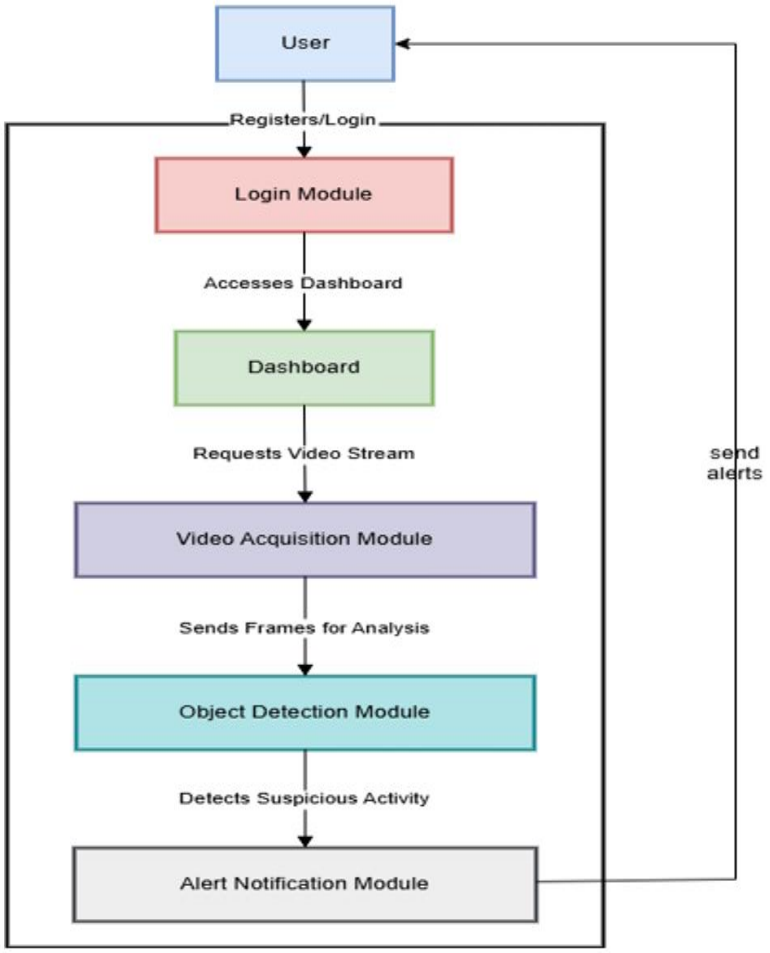
II.SYSTEM ARCHITECTURE



Vision Vault: Intelligent Video Surveillance System is an AI-powered security solution that transforms live camera feeds into actionable intelligence. The system begins with secure user authentication through its Login Module, granting access to a comprehensive Dashboard for realtime monitoring. High-definition video streams are captured and enhanced through advanced preprocessing algorithms before being analyzed by the YOLOv8-powered Object Detection Module, which identifies and tracks people and objects with exceptional accuracy.

The system's specialized modules provide layered security: Face Recognition verifies identities while Object Classification flags potential threats. Occupancy Detection monitors crowd density, and the Anomaly Detection Engine uses behavioral analysis to spot suspicious activities. When threats are detected, instant alerts with visual evidence are dispatched via email.

Designed for seamless integration, Vision Vault's modular architecture adapts to various environments while maintaining compliance with data protection standards. The system continuously improves through machine learning, delivering precise threat detection with minimal false alarms for comprehensive, intelligent security monitoring.

III.METHODOLOGY

This section details the systematic approach adopted to design and develop Vision Vault, an AI powered surveillance solution for real-time threat detection and security automation. The methodology comprises Four core components: System Architecture, Data Acquisition & Processing, Model Development and System Integration & Evaluation.

1. System Architecture

The proposed system follows a layered modular architecture to ensure scalability, accuracy, and efficiency. It consists of the following components:

Input Module – The system employs high-resolution surveillance cameras to continuously capture real-time video feeds from monitored environments. These cameras provide clear, detailed footage essential for accurate object detection

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and tracking. The vision-based capture mechanism ensures reliable video input for subsequent processing and analysis.

Processing Unit – Video streams undergo preprocessing where frames are enhanced and formatted for optimal analysis. The system then applies advanced computer vision algorithms to detect and classify objects in real-time.

Output Mechanism – Detected objects and potential threats are highlighted through visual indicators on the monitoring interface. The system generates automated alerts for security personnel when predefined conditions are met.

Backend & Database – The system backend, developed using Python handles user authentication, database operations, and data storage using SQLite. RESTful APIs are utilized for seamless communication between the frontend and backend.

2.Data Acquisition & Processing

The development of system began with comprehensive data collection to ensure high-precision detection and analysis.

Video Data Collection – High-resolution surveillance cameras captured real-time footage from office environments, including diverse scenarios such as crowded spaces, low-light conditions, and varying angles to ensure robust model training.

Annotated Dataset Creation – Recorded video samples were manually labelled with bounding boxes and classifications (e.g., person, suspicious object) to train the object detection model.

Preprocessing Techniques –Applied frame normalization, noise reduction, and contrast enhancement to optimize video quality. Feature extraction methods (HOG, CNN-based embeddings) were used to improve detection accuracy.

Behavioural Data Augmentation – Synthetic data generation simulated rare but critical events (e.g., unauthorized access, unattended objects) to enhance anomaly detection performance.

3. Model Development

The system employs deep learning models to achieve high-precision surveillance detection and analysis.

Object Detection – Utilizes YOLOv8 which is the backbone for real-time identification of people and objects in video streams.

Behaviour Analysis – Combines 3D CNNs for spatial-temporal feature extraction with Graph Neural Networks to model interactions between detected objects.

Anomaly Detection – Implements hybrid models using isolation forests and LSTMs to identify unusual activities and potential threats.

Face Recognition – Employs Arc Face architecture which serves as the foundation for accurate identity verification and access control in surveillance footage.

4. System Integration & Evaluation

The final phase of development focused on integrating all components and evaluating system performance.

Frontend Development – The user interface was developed using Flask, ensuring ease of use and accessibility.

Backend & Database Management – Python manage application logic and SQLite for user authentication.

Testing & Validation – The system underwent:

- **Integration Testing** – Verified complete system functionality and data flow between all operational modules.
- **User Evaluation**– Involved security personnel and facility managers, who assessed interface usability and practical effectiveness.

Performance Metrics – The system was evaluated based on detection accuracy, processing speed, alert precision, and system scalability to ensure consistent operational performance.

IV.OBJECTIVES OF PROJECT

Real-Time Threat Detection: Develop an intelligent surveillance system capable of detecting and classifying objects in real-time using YOLO v8 for proactive security monitoring.

Automated Anomaly Detection: Implement AI-driven behaviour analysis to identify suspicious activities such as loitering, unattended objects, and unauthorized access, reducing reliance on manual monitoring.

Face Recognition for Access Control: Integrate TensorFlow-based face recognition to authenticate individuals and restrict access to secure areas, enhancing overall security.

Real-Time Alerts and Notifications: Design an alert system that sends instant notifications (via SMS or email) to security personnel when anomalies or security breaches are detected.

Scalable and Modular Design: Create a system architecture that is modular and scalable, allowing for easy integration with existing infrastructure and adaptability to various environments.

User-Friendly Monitoring Interface: Develop an intuitive dashboard for monitoring, configuration, and review of surveillance data, ensuring ease of use for security personnel.

Enhanced Workplace Safety and Compliance: Provide tools for occupancy detection and crowd management to ensure compliance with safety regulations and optimize space utilization.

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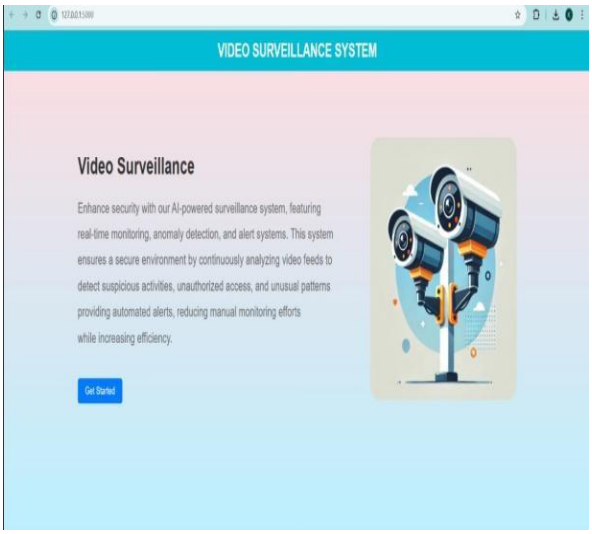
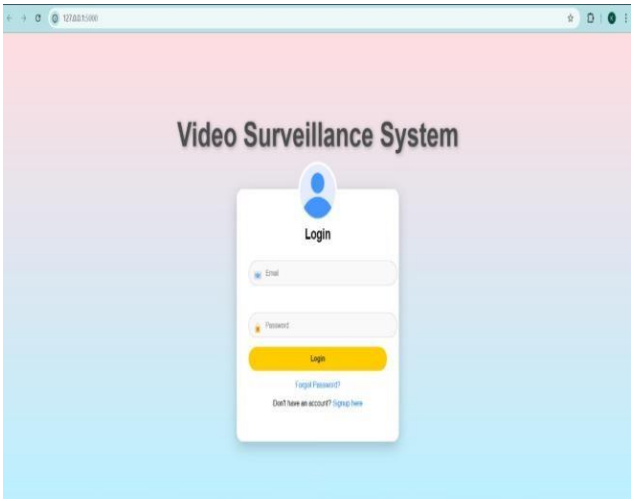
V.OUTPUTS

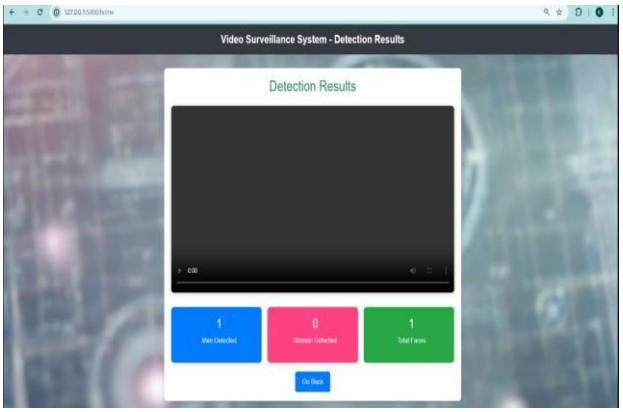


1.Home Page

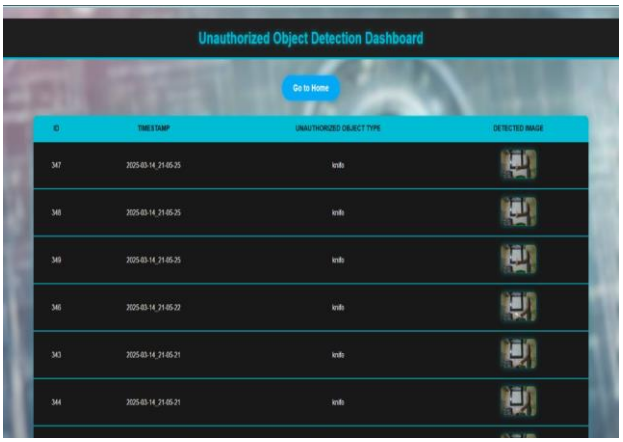


2. Login Page

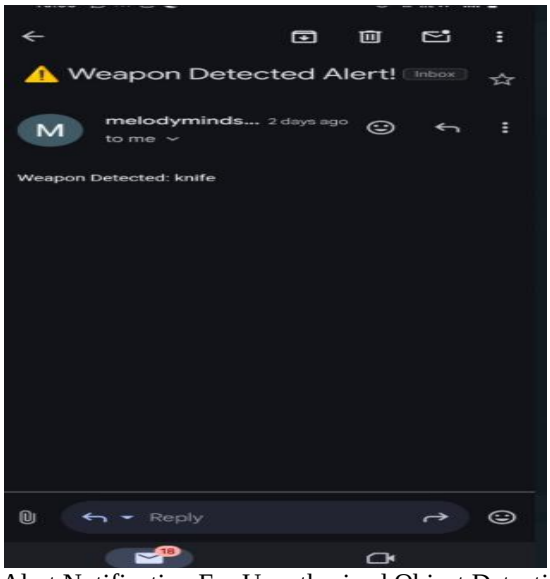
3. Dashboard



4. Gender Detection



5. Unauthorized Object Detection Dashboard



6. Alert Notification For Unauthorized Object Detection

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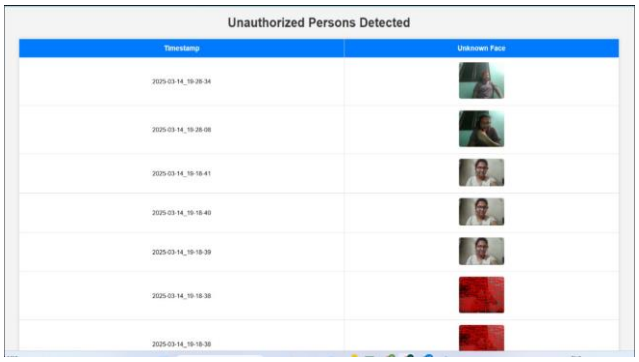
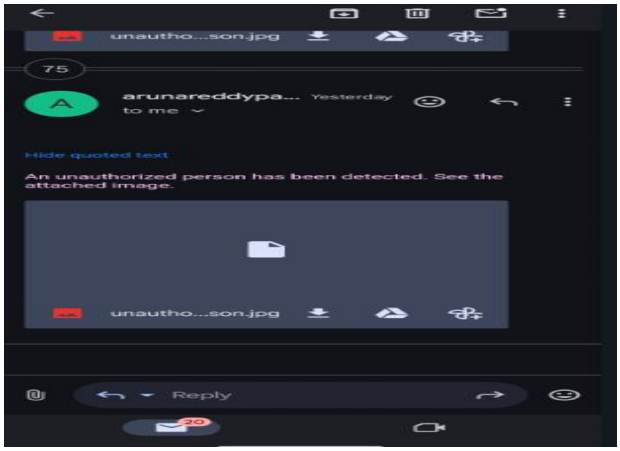


7. Unauthorized Person Detection Dashboard



8. Alert NotificationFor Unauthorized Person

VI.CONCLUSION

The **Vision Vault: Intelligent Video Surveillance System** successfully integrates **AI-driven technologies** like YOLO v8, TensorFlow, and OpenCV to automate real-time threat detection, anomaly recognition, and access control. Its modular design, real-time alerts, and user-friendly interface enhance security, reduce manual effort, and provide actionable insights, making it a robust solution for modern surveillance needs.

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