

A
PROJECT REPORT
on
“Vision Guard : AI-Based Surveillance System”
SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE
DEGREE OF
B.TECH (COMPUTER SCIENCE AND ENGINEERING)
of
Dr. Babasaheb Ambedkar Technological University, Lonere

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ACADEMIC YEAR 2024-2025

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ACADEMIC YEAR 2024-2025



CERTIFICATE

This is to certify that the project entitled, **“Vision Guard : AI-Based Surveillance System”** submitted by Mr. Om Shridhar Ambekar (2262171242058), Mr. Roshan Prakash Bhatale (2262171242005), & Mr. Shivprasad Satish Mali (2262171242103) is record of bonafide work carried out by them, under my guidance, in partial fulfillment of the requirement for the award of Degree of Bachelors of Technology (Computer Science and Engineering) of Dr. Babasaheb Ambedkar Technological University, Lonere for the academic year 2024-2025.

Date: 16 / 07 /2025

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ACKNOWLEDGEMENT

It gives us immense pleasure to express our sincere hearty gratitude towards our guide **Prof. P. R. Jadhav** for his/her constant help; encouragement and suggestions given to us for presenting our dissertation work entitled “**Vision Guard : AI-Based Surveillance System**”.

We are thankful to **Dr. S. R. Chougule, Director, AMGOI** for continuously encouraging us. We are also thankful to **Prof. P. B. Ghewari, Vice Principal** for continuous motivation towards our project. We would like to thank **Prof. S. S. Redekar, (HOD)** who helped us to build this project. We extend our thanks to staff members of Computer Science and Engineering Department and all our friends who have extended their cooperation for the completion of this task

Finally, we express our gratitude to Almighty **GOD** and our **PARENTS** who have inspired & supported us to complete this work, without their support we could not have completed this task.

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Abstract

Vision Guard: AI-Based Surveillance System is an intelligent security solution designed to enhance monitoring and threat detection capabilities using advanced artificial intelligence technologies. The system integrates real-time video surveillance with AI-powered analytics to automatically detect unusual activities, unauthorized access, and potential security breaches in both public and private environments. By utilizing computer vision, object recognition, and behaviour analysis, Vision Guard minimizes the need for constant human supervision while increasing the accuracy and speed of response to potential threats. The system is capable of identifying suspicious movements, tracking individuals across multiple cameras, and generating instant alerts to security personnel. Its scalable architecture supports integration with existing surveillance infrastructure, making it suitable for smart cities, corporate facilities, educational campuses, and other high-security zones. Vision Guard aims to revolutionize traditional surveillance by providing proactive, data-driven security management, thereby ensuring improved safety, faster decision-making, and reduced operational costs. This project highlights the potential of AI to transform security systems into more intelligent and responsive platforms.



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Chapter 1: Introduction

1.1 Introduction

In today's fast-evolving digital landscape, security and surveillance have become critical components of personal, public, and organizational safety. Traditional surveillance systems often rely heavily on manual monitoring, which is time-consuming, prone to human error, and limited in scalability. To address these challenges, Vision Guard: AI-Based Surveillance System is developed as an innovative solution that leverages the power of artificial intelligence to enhance real-time monitoring, automate threat detection, and improve response efficiency. By integrating computer vision, machine learning, and intelligent video analytics, Vision Guard transforms conventional CCTV setups into smart, proactive security systems. It is capable of identifying abnormal activities, recognizing faces and objects, and tracking movement across multiple zones with high accuracy. This system is designed to adapt to various environments such as smart cities, corporate buildings, educational institutions, and industrial zones. The aim of this project is to create a reliable, scalable, and intelligent surveillance platform that not only enhances security but also reduces dependency on constant human oversight.

1.2 Relevance

The Vision Guard: AI-Based Surveillance System is highly relevant in today's world, where security threats are becoming more frequent and complex. Traditional surveillance methods, which rely on continuous human monitoring, are not only resource-intensive but also susceptible to fatigue and oversight. With the growing need for efficient and intelligent security solutions in public spaces, workplaces, and critical infrastructures, AI-powered surveillance offers a transformative approach. Vision Guard addresses this need by using advanced technologies such as computer vision and machine learning to detect suspicious behavior, unauthorized access, and potential threats in real time.

This project is particularly significant in the context of smart city development, rising urbanization, and increasing demand for 24/7 automated surveillance. Its relevance extends to areas such as crime prevention, crowd management, facility monitoring, and emergency response. By providing accurate, real-time insights and reducing the burden on human operators, Vision Guard contributes to safer environments and more effective security systems, making it a timely and impactful innovation in the field of surveillance technology.

1.3 Problem definition

Traditional surveillance systems primarily depend on human operators to monitor video feeds and detect unusual or suspicious activities. This manual process is not only time-consuming and inefficient but also prone to errors due to fatigue, distraction, or oversight. As the volume of surveillance data increases with the expansion of urban areas and security-sensitive zones, it becomes increasingly difficult to ensure timely and accurate threat detection. Moreover, existing systems often lack real-time analysis capabilities and the intelligence needed to identify potential threats proactively. They typically function as passive monitoring tools rather than active security solutions. This creates a critical gap in safety and response effectiveness, especially in high-risk or large-scale environments such as smart cities, corporate campuses, transportation hubs, and public events. The Vision Guard: AI-Based Surveillance System project aims to solve this problem by automating surveillance using artificial intelligence, thereby enabling real-time threat detection, behavior analysis, and instant alert generation without the need for constant human intervention.

1.4 Objectives

The main objectives of the Vision Guard: AI-Based Surveillance System project are as follows:

- a. To develop an intelligent surveillance system that uses artificial intelligence and computer vision for real-time monitoring and automated threat detection.
- b. To reduce dependency on human operators by implementing smart algorithms that can analyze video feeds, recognize patterns, and detect abnormal or suspicious activities.
- c. To ensure quick and accurate response by generating instant alerts for security breaches, unauthorized access, or unusual behavior.
- d. To enhance the efficiency and effectiveness of existing surveillance infrastructure through seamless integration with AI-based analytics.
- e. To improve safety and security in various environments such as smart cities, corporate offices, educational institutions, and public spaces.
- f. To provide scalability and flexibility, allowing the system to adapt to different locations, camera networks, and security needs.
- g. To demonstrate the practical application of AI technologies in the field of surveillance and showcase their potential to transform traditional security system.

Chapter 2: Literature Survey

2.1 Literature Survey

The increasing need for robust security solutions has driven extensive research and development in the field of intelligent surveillance systems. Conventional CCTV-based surveillance systems have limitations such as reliance on human monitoring, delayed responses, and limited scalability. Over the past decade, researchers and developers have focused on integrating Artificial Intelligence (AI), Computer Vision, and Internet of Things (IoT) technologies to create smarter, automated, and more efficient surveillance solutions. This section explores the key findings, methodologies, and technological advancements from existing literature.

a. Traditional Surveillance Systems

Conventional surveillance relies heavily on manual operations, where security personnel monitor video feeds from cameras. According to Jain et al. (2016), such systems are often inefficient due to human fatigue, limited attention span, and the inability to track multiple feeds simultaneously. Although these systems provide visual evidence after an incident occurs, they lack the real-time intelligence required to prevent or respond swiftly to threats.

b. AI-Based Video Analytics

Recent studies, such as those by Zhang et al. (2019), demonstrate that AI algorithms can be trained to analyze live video feeds for detecting suspicious behavior, facial recognition, license plate identification, and abandoned object detection. These AI models, especially those using deep learning and convolutional neural networks (CNNs), have shown significant accuracy in pattern recognition and anomaly detection.

c. Behavior Recognition and Object Tracking

Behavior analysis plays a critical role in smart surveillance. Research by Li and Wu (2020) explores the use of Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) models for behavior prediction and abnormal activity recognition. Object tracking algorithms like YOLO (You Only Look Once), SSD (Single Shot Detector), and Deep SORT are commonly used for real-time monitoring and tracking individuals across multiple camera feeds.

d. Smart Surveillance Applications

Intelligent surveillance systems have found applications in diverse areas such as public safety, traffic monitoring, access control, and crowd management. In smart cities, AI-enabled surveillance has helped authorities reduce crime rates, detect traffic violations, and improve emergency responses. The literature also emphasizes the importance of data privacy, ethical AI use, and system reliability for widespread deployment.

e. Limitations and Research Gaps

Despite the promising capabilities of AI-based surveillance, challenges remain in ensuring real-time performance, accuracy in crowded or low-light environments, and privacy concerns. There is a need for systems that are not only technically advanced but also cost-effective, scalable, and adaptable to various operational scenarios. Moreover, integrating AI seamlessly with legacy infrastructure remains a practical hurdle.

2.2 Problem Statement

Traditional surveillance systems are primarily passive in nature and heavily reliant on continuous human monitoring. This leads to several limitations, such as human fatigue, delayed response to incidents, and the inability to monitor multiple feeds effectively. In large and dynamic environments like public spaces, corporate campuses, or transportation hubs, the lack of real-time analysis results in missed threats and inefficiencies in security management. Furthermore, existing systems do not offer automated behavior analysis, threat prediction, or intelligent alert mechanisms, which are critical for modern security needs. There is a pressing need for an AI-powered surveillance system that can automatically detect, analyze, and respond to potential threats in real time, reducing human effort and enhancing overall security effectiveness.

2.3 Problem Solution

The proposed solution is the Vision Guard: AI-Based Surveillance System, which aims to overcome the limitations of traditional surveillance by integrating artificial intelligence and computer vision. This system will utilize advanced deep learning models for object detection, facial recognition, and behavior analysis to automatically monitor video feeds and identify potential threats without the need for constant human supervision.

Key features of the system include:

- a. Real-Time Monitoring using AI algorithms to detect and analyze abnormal behavior or security breaches.
- b. Object and Person Detection through pretrained models like YOLOv8 or SSD for accurate tracking across frames.
- c. Automated Alerts to notify security personnel instantly in case of suspicious activity or violations.
- d. Scalability and Integration with existing camera systems and cloud infrastructure for ease of deployment.
- e. Data Storage and Analysis for post-incident investigation, pattern recognition, and system learning improvement.

Chapter 3: Working Model

3.1 Related Work

Several intelligent surveillance systems have been developed in recent years that utilize artificial intelligence and computer vision to improve the efficiency and responsiveness of monitoring environments. Some notable works include:

- a. FaceNet and OpenCV-based Recognition Systems: Projects integrating OpenCV with face recognition models such as FaceNet have been used to identify individuals in real-time video streams, mainly for attendance tracking and security access.
- b. YOLOv4 and YOLOv8-based Object Detection: These models are widely adopted in real-time object and person detection due to their high speed and accuracy. They are commonly used for tracking people, detecting weapons, or monitoring unusual activities in public areas.
- c. Smart City Surveillance Platforms: Cities like Singapore and Dubai have implemented AI-driven surveillance that combines traffic monitoring, facial recognition, and anomaly detection to enhance law enforcement and emergency response.
- d. CCTV Integration with Deep Learning: Many smart surveillance systems integrate existing CCTV infrastructure with deep learning modules for live feed analysis. Projects like DeepStream by NVIDIA are examples of such integration, showcasing how GPUs accelerate real-time analytics.

The *Vision Guard* system builds upon these advancements by providing a unified platform that combines multiple AI capabilities—including object detection, behavior analysis, and automated alerts—into a cost-effective and scalable solution.

3.2 System Requirements

To implement the *Vision Guard* system effectively, both software and hardware components are essential. Below are the detailed requirements.

3.2.1 Software Requirements

Software Component	Description
Operating System	Windows 10 / Linux (Ubuntu 20.04 or above)
Programming Language	Python 3.x

Software Component	Description
Libraries and Frameworks	OpenCV, TensorFlow, Keras, PyTorch, NumPy, Pandas
Deep Learning Models	YOLOv8 (You Only Look Once), Haar Cascades
Database (optional)	MySQL / SQLite (for storing logs and alerts)
IDE/Code Editor	VS Code / Jupyter Notebook / PyCharm
Web Technologies (optional)	Flask / Django (for web-based interface)

3.2.2 Hardware Requirements

Hardware Component	Specification
Processor (CPU)	Intel i5 or higher (i7/i9 preferred for faster processing)
Graphics Card (GPU)	NVIDIA GTX 1050 or higher (e.g., RTX 2060)
RAM	Minimum 8 GB (16 GB recommended)
Camera	HD USB/Webcam or IP Camera (1080p or higher)
Storage	Minimum 256 GB SSD (for video storage and logs)
Display Monitor	For real-time output and analysis display
Internet Connectivity	For cloud-based backup, remote access.

3.3 System Design

The system design of *Vision Guard* follows a modular and layered architecture for efficient performance, scalability, and ease of maintenance. The major components are as follows:

A. Input Layer (Camera Feed)

The system receives real-time video input from one or more cameras. These can be standard webcams or IP cameras connected over a local or cloud network.

B. Processing Layer

- a. **Frame Capture:** The video is converted into individual frames using OpenCV.
- b. **Preprocessing:** Each frame is resized, normalized, and fed into the AI model for analysis.
- c. **Object Detection:** YOLOv8 or similar deep learning models detect people, vehicles, weapons, or suspicious objects.

- d. Face Recognition (Optional): Facial features are extracted and compared with stored records to recognize individuals.
- e. Behavior Analysis: Movement patterns are analyzed to detect abnormal or suspicious behavior using RNN/LSTM models or rule-based algorithms.

C. Alert and Logging Module

- a. When a threat or anomaly is detected, an alert is immediately generated.
- b. Notifications can be sent via email, SMS, or through a mobile/web dashboard.
- c. All events are logged and timestamped for review and future training.

D. Storage and Reporting

- a. All captured frames or clips of suspicious activity are stored locally or in a cloud database.
- b. Logs can be exported for administrative review or incident investigation.

E. User Interface (Optional)

Simple dashboard is designed using Flask or Django to display:

- a. Live camera feeds
- b. Alerts and logs
- c. Historical data and statistics
- d. Admin control for camera settings and user access

3.3.1 DFD Diagrams (Level 0 & Level 1)

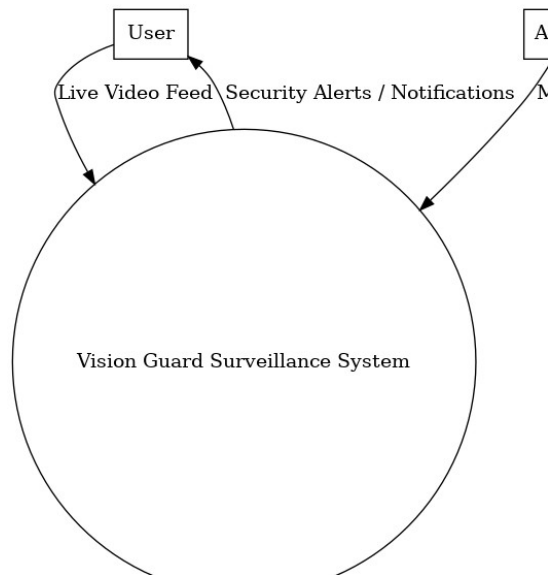


Fig. 3.3.1.1 Level 0 DFD

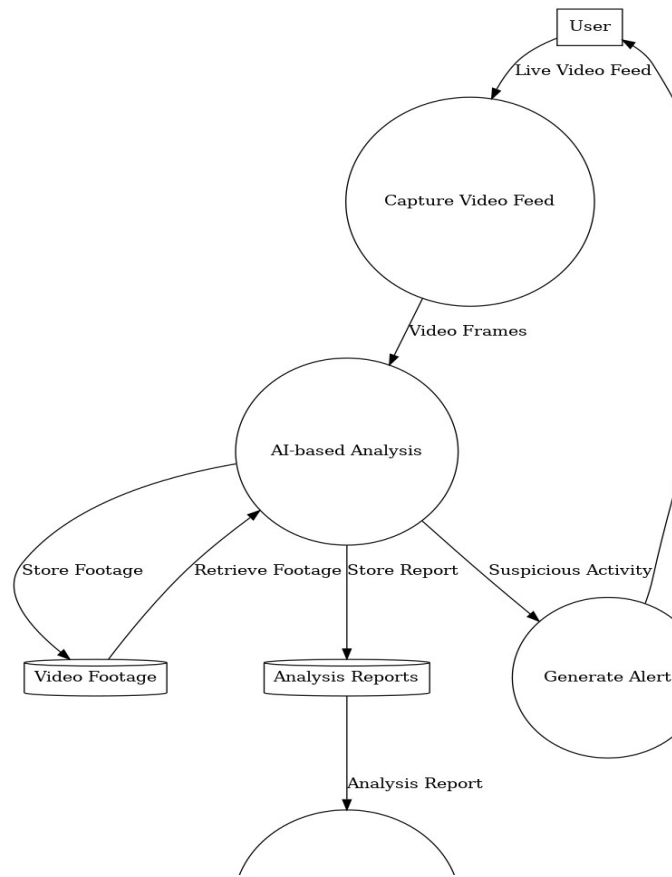


Fig. 3.3.1.2 Level 1 DFD

3.3.2 System Architecture, Use case /sequential /component diagram etc

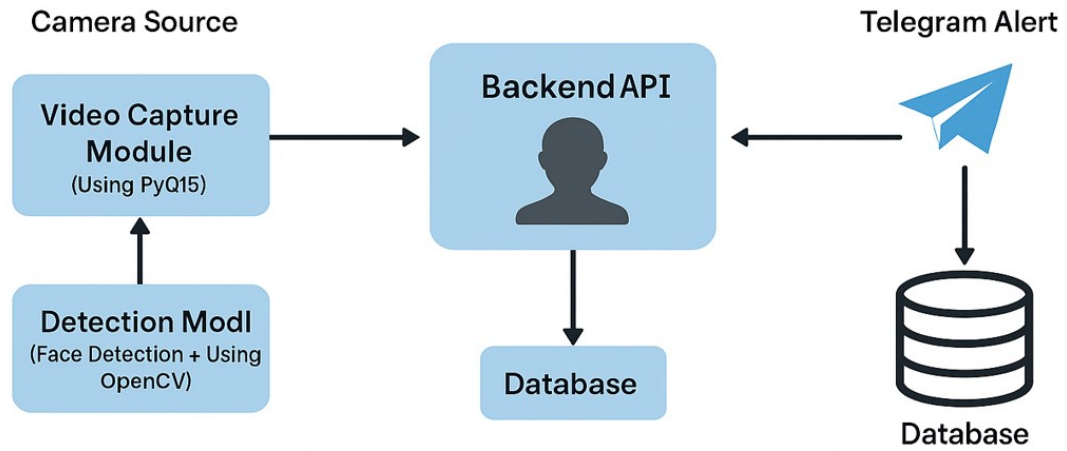


Fig. 3.3.2.1 System Architecture of Vision Guard

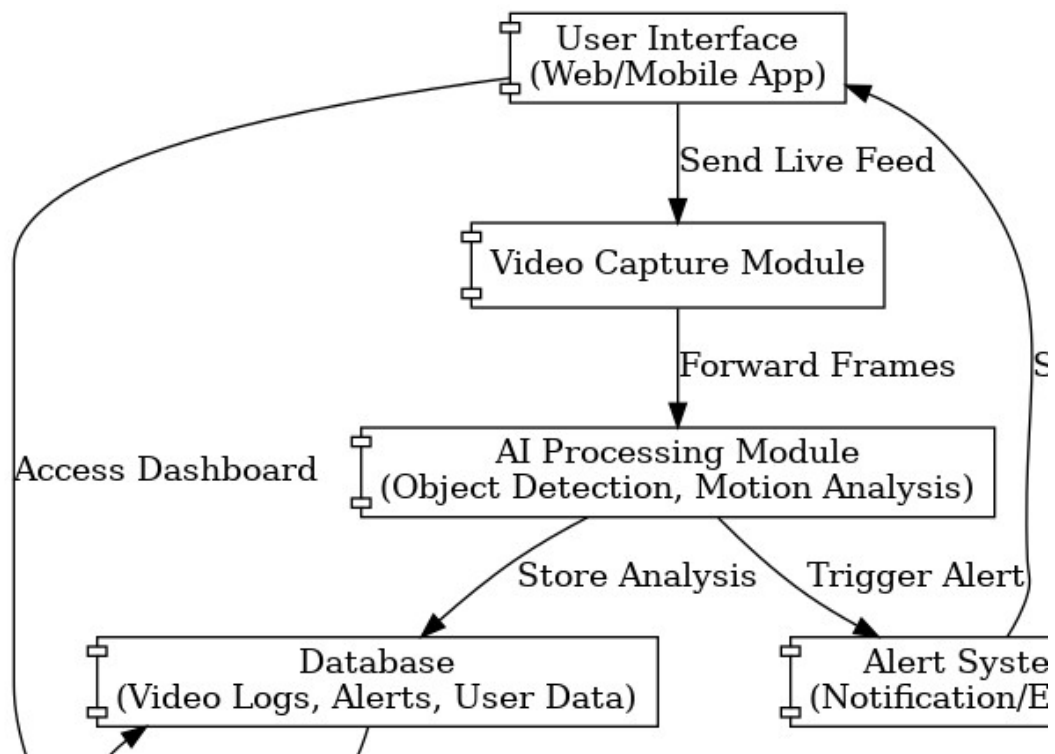


Fig. 3.3.2.2 Component diagram

Chapter 4: Technical Content / Main Part of Project

4.1 Details of Front-End Project

The front end of the *Vision Guard* system is designed to offer an intuitive, responsive, and informative interface for users such as security personnel and administrators. It allows real-time monitoring, alert visualization, and access to historical surveillance data. The front end is implemented using modern web technologies and includes the following components:

A. Technology Stack:

- a. HTML5, CSS3: For layout, structure, and design of the interface.
- b. JavaScript: For interactive features and dynamic updates.
- c. Bootstrap/Tailwind CSS: For responsive and clean UI design.
- d. Flask / Django Templates: For rendering data from the backend to the front end.
- e. AJAX (Optional): For fetching real-time updates without page reloads.

B. UI Features:

- a. Live video stream from connected surveillance cameras.
- b. Dashboard with system alerts (e.g., unauthorized access, abnormal motion).
- c. User login system with role-based access.
- d. History tab to review previously detected incidents and footage.
- e. Status indicators for camera health and system functionality.

C. Security Features:

- a. User authentication and session management.
- b. Encrypted credentials (if login system implemented).

4.2 Details of Back-End Project

The back end of *Vision Guard* is responsible for handling AI processing, video analysis, data storage, and alert generation. It acts as the brain of the system where most surveillance intelligence is implemented.

A. Programming Language: Python 3.x

B. AI & Computer Vision Libraries:

- a. OpenCV: For frame capture, processing, and basic video operations.

- b. YOLOv8 / TensorFlow / PyTorch: For real-time object detection and face recognition.
 - c. NumPy / Pandas: For image array handling and data operations.
 - d. Deep SORT or custom tracking algorithms: For person tracking and object movement.
- C. Back-End Framework:
- a. Flask or Django to handle routing, APIs, and server-side logic.
- D. Database:
- a. SQLite or MySQL: For storing logs, alerts, user records, and configuration.
 - b. Schema Includes:
 - i. alerts (id, timestamp, event_type, location, severity)
 - ii. users (id, username, role, password_hash)
 - iii. video_logs (id, filepath, date, associated_alert_id)
- E. Core Functions:
- a. Read live video feed and split into frames.
 - b. Analyze each frame using AI models.
 - c. Detect faces, objects, and suspicious behaviors.
 - d. Generate alerts when predefined conditions are met.
 - e. Save clips of the incidents to local/cloud storage.
 - f. Log events in the database for review and reporting.

4.3 Connection Between Front End and Back End – Entire Details

The integration between the front end and back end forms the complete operational pipeline of *Vision Guard*. The communication is handled primarily via HTTP requests and API endpoints, enabling a seamless flow of data and functionality.

Working Flow:

1. Live Feed Processing:
 - i. The video feed from the camera is sent to the Python backend (Flask/Django).

- ii. The backend captures frames and processes them using object detection and facial recognition models.

2. AI Analysis:

If a suspicious activity is detected, the backend logs the event, saves the relevant video snippet, and flags it as an alert.

3. API Communication:

- a. The backend exposes RESTful APIs that the front end uses to:
 - i. Fetch live alerts (GET /api/alerts)
 - ii. Access video logs (GET /api/videos)
 - iii. Display system statistics (GET /api/system_status)

4. Frontend Rendering:

- i. The dashboard queries the backend using AJAX or server-side rendering to update alerts and video feeds in real-time.
- ii. Users can log in to view personalized alerts, review event history, or download footage.

5. Security & Authentication:

User authentication tokens or session-based login systems are used to manage secure access to frontend and backend resources.

Chapter 5: Implementation

5.1 Implementation Screenshot/ Snaps

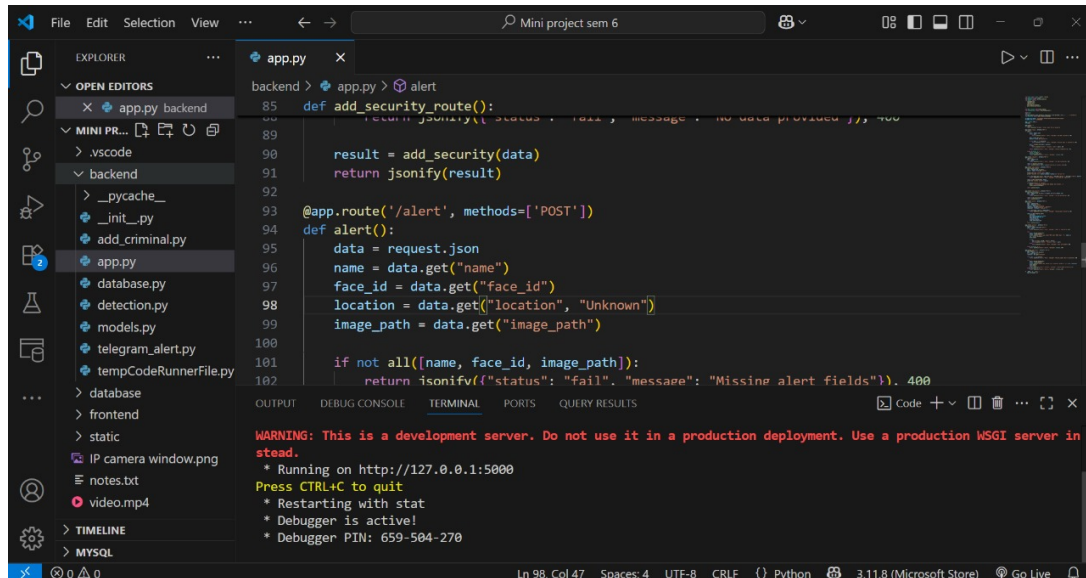


Fig. 5.1.1 Alert Code Snippet

This image shows the backend implementation of the Vision Guard project in Flask using Python. It defines an API route (/alert) to receive alert data like name, face ID, location, and image path from the AI surveillance system.

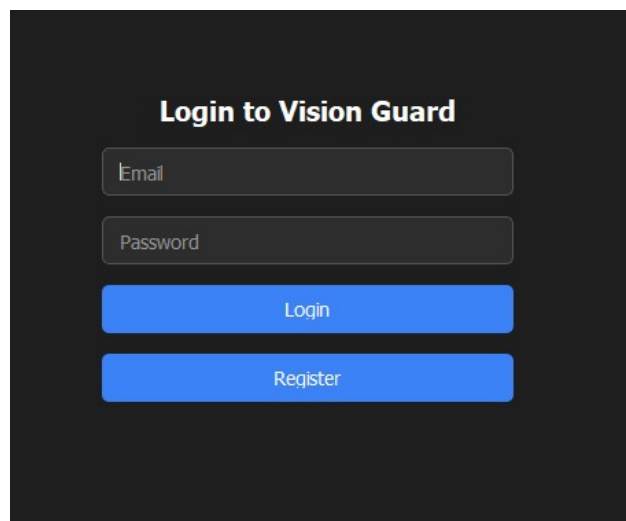
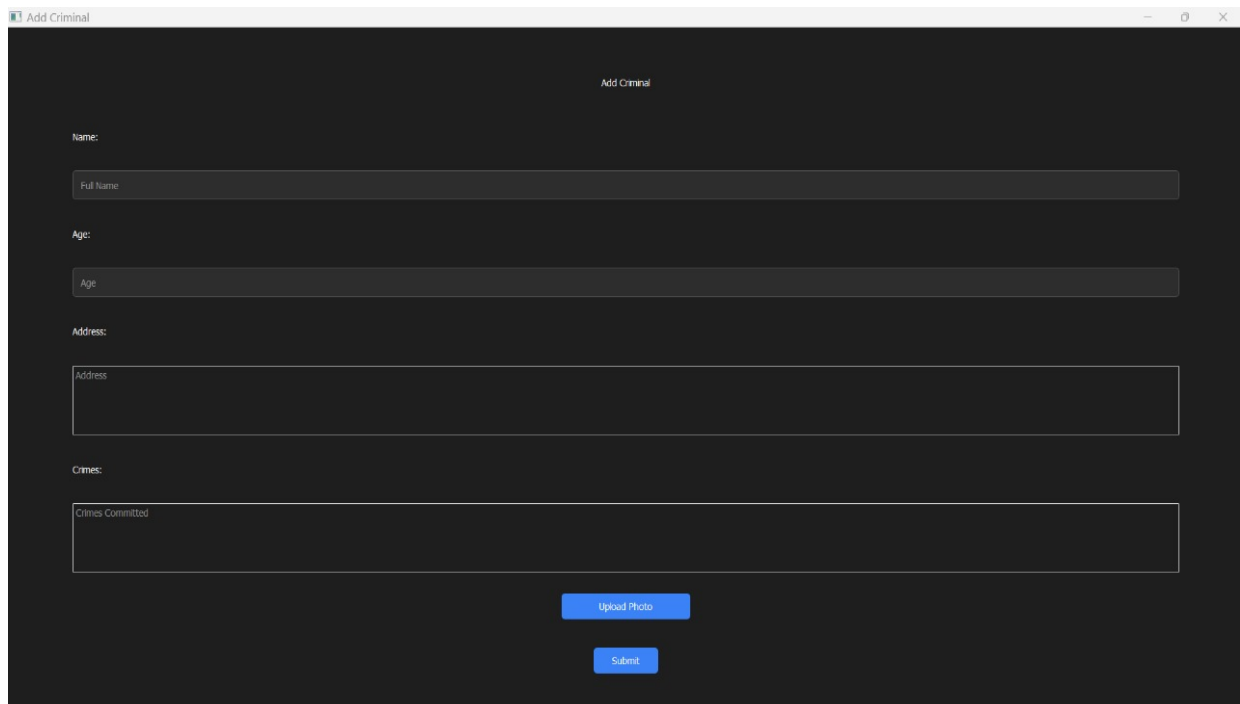


Fig. 5.1.2 Login Page

This is the login interface of the Vision Guard system, allowing users to securely access the platform using their email and password. It also provides an option to register new users for authorized access.



The screenshot shows a web application window titled "Add Criminal". The form is set against a dark background and includes the following fields:

- Name:** A text input field with the placeholder "Full Name".
- Age:** A text input field with the placeholder "Age".
- Address:** A large text input area with the placeholder "Address".
- Crimes:** A large text input area with the placeholder "Crimes Committed".

At the bottom of the form, there are two blue buttons: "Upload Photo" and "Submit".

Fig. 5.1.3 Add Criminal Data

The Add Criminal Data Profile form is used to input and store detailed information about identified or suspected individuals. It helps the system maintain a criminal database for quick recognition and future alert generation using AI surveillance.

5.2 Output

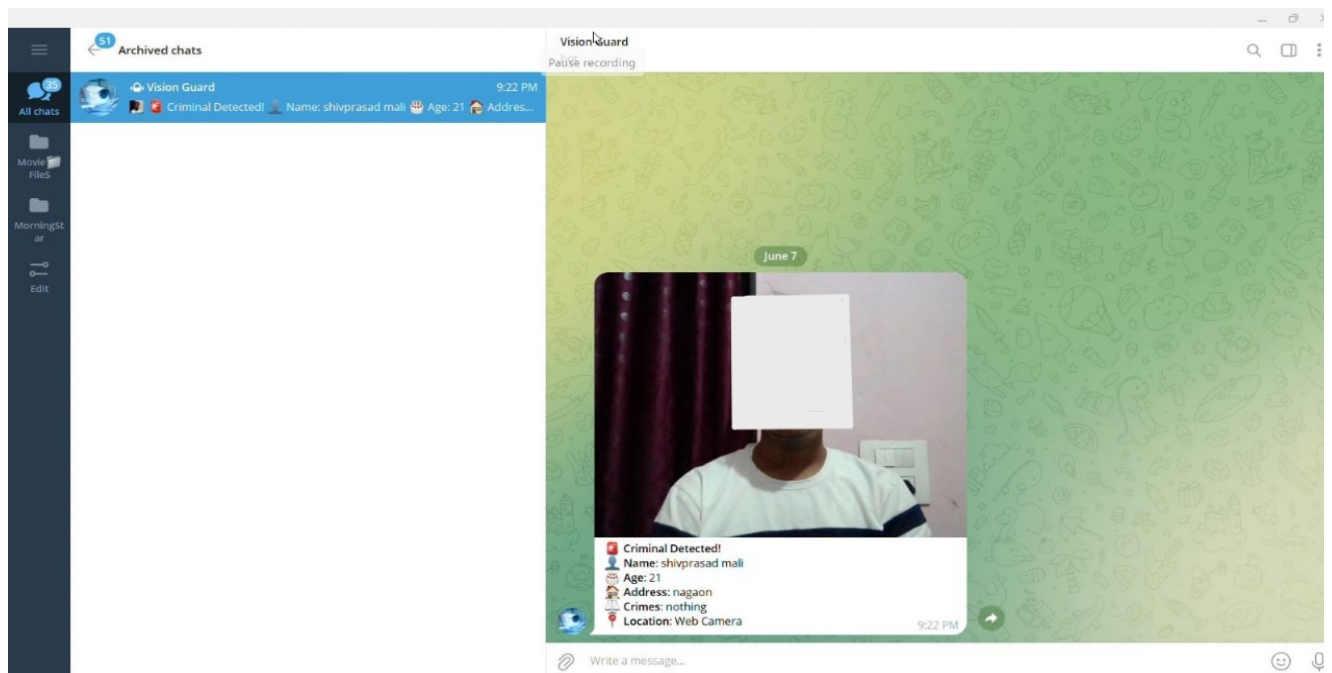


Fig. 5.2.1 Alert from Telegram Bot

5.3 System Testing and Test Result

The system was tested using live camera feeds with pre-registered criminal profiles. When a criminal was detected through the object and face recognition model, the backend triggered an alert with details like name, face ID, and location. This alert was successfully sent to a configured Telegram bot. The test cases included detection under different lighting conditions and distances. Overall, the system demonstrated accurate detection and fast alert delivery within 2–4 seconds of recognition.

5.4 Results and Discussion

The implementation of Vision Guard with Telegram integration proved highly effective for real-time threat notification. The system successfully recognized known faces and pushed structured alert messages (with images) directly to the Telegram channel. This eliminated the delay of manual monitoring and improved responsiveness. Some false positives were observed under poor lighting, indicating room for model optimization. However, the integration of AI detection and instant messaging marks a significant improvement over traditional surveillance systems.

Chapter 6: Limitations and Conclusion

6.1 Applications

The *Vision Guard* system has broad applications across various domains where security and monitoring are critical. Its real-time AI-based surveillance features make it suitable for the following areas:

- A. Smart Cities: Automated monitoring of public areas, traffic intersections, and event zones for crime detection and traffic violations.
- B. Corporate Offices & IT Parks: Entry-point security, employee movement tracking, and asset protection.
- C. Educational Institutions: Monitoring school/college campuses to detect intrusions, unauthorized access, or aggressive behavior.
- D. Airports, Stations, and Transport Hubs: High-accuracy object and person detection to prevent suspicious activities and enhance crowd management.
- E. Residential Societies & Gated Communities: 24/7 surveillance with automatic alert generation for unauthorized entry or theft.
- F. Retail Stores & Warehouses: Shoplifting prevention, unauthorized area monitoring, and resource protection.

6.2 Limitations

Despite its intelligent features, the current version of the *Vision Guard* system has certain limitations:

- A. Hardware Dependency: The system's real-time performance heavily depends on high-end GPUs and processing units for smooth AI model inference.
- B. Lighting and Weather Sensitivity: Accuracy of detection may reduce in poor lighting conditions, fog, or heavy rain, affecting camera visibility.
- C. False Positives/Negatives: AI models can occasionally misclassify normal behavior as suspicious or fail to detect actual threats, especially in crowded or complex scenes.
- D. Privacy Concerns: Use of face recognition and behavioral tracking may raise ethical and legal concerns regarding personal data and surveillance.

- E. Limited Multi-Camera Tracking: Advanced tracking across multiple non-overlapping camera angles requires more complex architecture and synchronization.

6.3 Future Work

To overcome current limitations and enhance system performance, the following improvements are proposed for future development:

- A. Edge AI Optimization: Deploying models on edge devices like NVIDIA Jetson to improve performance in low-resource environments.
- B. Advanced Behavior Prediction: Incorporating LSTM or transformer-based models to better understand and predict complex human behaviors.
- C. Crowd Density Analysis: Adding heatmaps and crowd estimation features for crowd control in public events or transportation hubs.
- D. Voice & Audio Analysis: Integrating sound recognition (e.g., glass breaking, shouting) to complement visual detection.
- E. Privacy Protection: Implementing anonymization techniques and GDPR-compliant data handling policies.
- F. Cloud Integration: Enable live remote access, cloud storage, and centralized control from a secure server platform.

6.4 Conclusion

The *Vision Guard: AI-Based Surveillance System* presents a powerful solution to modern-day security challenges by integrating artificial intelligence with real-time video surveillance. It reduces reliance on manual monitoring, provides faster incident detection, and enables proactive response through intelligent alerts. By combining object detection, behavior analysis, and automated reporting, it significantly enhances situational awareness and operational efficiency. While the current system demonstrates strong performance in controlled environments, ongoing enhancements are needed to improve scalability, accuracy, and privacy compliance. Overall, this project lays a solid foundation for future advancements in smart surveillance and highlights the transformative role of AI in the field of security and monitoring.

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