

Ai Based Person Detection and Alert System in Restricted Area Using Raspberry Pi

Dr. Shah S.N¹, Prof. Bhagat.P. V², Godage Aniket³, Khunte Nandini⁴, Nazirkar Kajal⁵

¹Co-Ordinator, Department of Computer Engineering SPCOET, Someshwarnagar

²Guide, Department of Computer Engineering SPCOET, Someshwarnagar

^{3,4,5}Students, Department of Computer Engineering SPCOET, Someshwarnagar

Abstract— The AI-Based Person Detection and Alert System is a smart surveillance solution developed using Python on a Raspberry Pi to monitor restricted areas. The system captures real-time video through a camera module and processes it using Python-based libraries for image analysis. A lightweight deep learning model such as MobileNet SSD is implemented using TensorFlow Lite and OpenCV for efficient human detection. The system identifies unauthorized entry by defining a specific region of interest within the monitored area. When a person is detected inside the restricted zone, the system immediately triggers alerts such as sound alarms, email notifications, or mobile messages. Python is used for integrating all components including video processing, detection logic, and alert mechanisms. The system is designed to be cost-effective, energy-efficient, and suitable for continuous monitoring. It reduces the need for manual supervision while improving security and response time. The solution can be further enhanced with features like facial recognition, cloud connectivity, and real-time data logging. Future improvements may include IoT integration and advanced analytics for better accuracy. Overall, the system offers an automated, reliable, and scalable approach to security using Python-based implementation.

Index Terms—Python, Person Detection, Raspberry Pi, Surveillance System, Artificial Intelligence, OpenCV, TensorFlow Lite.

I. INTRODUCTION

In recent years, the rapid advancement of artificial intelligence and embedded systems has significantly transformed the field of security and surveillance. Modern monitoring systems are increasingly adopting intelligent technologies to improve real-time detection, automation, and response in sensitive and restricted areas. An AI-Based Person Detection and

Alert System is an important solution that helps in identifying unauthorized human presence and ensuring safety in secured environments.

1,2,7] Many organizations and institutions face challenges in continuously monitoring restricted areas due to the need for constant human supervision and the risk of delayed response. Traditional surveillance systems often rely on manual observation, which can lead to human errors and inefficiency. Therefore, there is a growing need for an automated system that can detect and respond to potential intrusions effectively. To address this problem, a 5]AI-Based Person Detection and Alert System using Raspberry Pi is proposed as a cost-effective and efficient solution. The system uses a camera module to capture real-time video and applies machine learning techniques for detecting human presence. By defining a specific region of interest, the system can accurately identify intrusions within restricted boundaries.

Furthermore, the use of 1,3,5] artificial intelligence enhances the system's accuracy and efficiency by minimizing false detections and enabling real-time decision-making. The combination of hardware and software technologies creates a reliable, low-cost, And Security Purpose. Overall, the AI-based person detection and alert system provide an effective approach to modern surveillance by automating monitoring tasks, improving response time, and ensuring better safety and security.

II. LITERATURE REVIEW

A literature survey, also known as a literature review, is an essential part of research that provides a detailed understanding of existing work related to a specific domain. It involves analyzing, comparing, and

synthesizing previous studies, technologies, and methodologies to establish a strong foundation for the proposed system. In the context of an AI-based person detection and alert system, the literature survey helps in identifying existing surveillance techniques, their limitations, and the need for intelligent and automated solutions.2,5] The rapid advancement in artificial intelligence, computer vision, and embedded systems has significantly improved the efficiency of modern security systems. Traditional surveillance methods mainly rely on continuous human monitoring, which is inefficient and prone to errors. Recent research focuses on automated detection systems that can identify human presence and trigger alerts in real time 6,20,15] Joseph Redmon et al., “You Only Look Once (YOLO)” This research introduced a real-time object detection system capable of detecting multiple objects, including humans, with high speed and accuracy. YOLO is widely used in person detection systems due to its ability to process images in a single pass, making it suitable for real-time applications.

- 7,11,13,17] Bodla et al., “Soft-NMS for Object Detection” This paper proposed an improved non-maximum suppression technique to enhance object detection accuracy. It helps reduce false detections, which is crucial in surveillance systems for reliable person identification.
- 1,6,15,3] Raspberry Pi Foundation, “Embedded Vision Systems using RaspberryPi” This work highlights the use of Raspberry Pi in building low-cost embedded vision applications. It demonstrates how Raspberry Pi can be integrated with cameras and AI models to perform real-time monitoring tasks efficiently.
- 3,7,9,12,15] Szeliski, R., “Computer Vision: Algorithms and Applications” This study provides a comprehensive overview of computer vision techniques used in image processing and object detection. It forms the theoretical basis for implementing person detection systems.
- 3,6,7,8] Various Researchers, “AI-based Surveillance and Security Systems”Recent studies focus on integrating machine learning models with IoT devices to create smart surveillance systems. These systems can detect human activity, send alerts, and store data for analysis, improving overall security and automation.

The literature survey highlights that although several

systems exist for surveillance, many are either expensive or lack real-time intelligent decision-making capabilities. This creates a need for a cost-effective and efficient solution using embedded systems and AI.

III. SYSTEM.ARCHITECTURE

Camera (Input Module)

This is the starting point of the system that captures live video and capturing the image in continuously. It sends the video feed to the processing unit for analysis.

Processing Unit (Raspberry Pi)

The Raspberry Pi acts as the core controller of the system. It receives video input and performs real-time processing. It connects all components like AI model, alert system, and data storage.

AI Model & Computer Vision

This module analyzes the video frames using Artificial Intelligence It detects the presence of a person using computer vision techniques. It ensures accurate and fast identification of objects or humans.

Detection Module

This component checks whether a person is detected in video. Once detection is confirmed, it generates a signal for action. It acts as a decision-making layer in the system.

Alert System

This module is responsible for notifying users when a include: Emailsends detailed alert messages to the user.

Data Storage (Processed Data)

The system stores the processed data after detection. This data can include detection logs, images, or timestamps. It helps in record keeping and monitoring.

Further Analysis

Stored data can be used for future improvements and analysis. It helps in enhancing model accuracy and system performance.

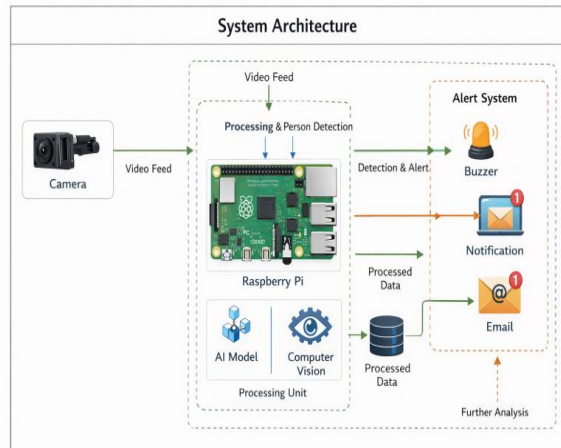


Fig. System Architecture

1. Frontend (User Interface):

Technologies: HTML, CSS, JavaScript, Bootstrap, AJAX **Purpose:** Provides a dashboard for users to monitor the system. Displays live video feed from the camera. Shows detection results, alerts, and system status. Allows users to configure settings (e.g., alert type, sensitivity).

2. Backend (Server Side):

Technologies: Python (Flask/Django) **Purpose:** Handles system logic and communication between components. Processes video data received from the camera. Integrates AI models for person detection. Manages alert triggering (buzzer, notification, email). Controls data flow between frontend and database.

3. Database:

Technologies: MongoDB **Purpose:** Stores that detection logs in Evidence (date, time, images). Maintains user details and system configurations. Keeps records of alerts and notifications. Helps in tracking and analyzing past activities.

4. Alert System Integration:

Technologies: IOT modules, Email APIs, Notification services **Purpose:** Sends real-time alerts when a person is detected. Activates the system buzzer for immediate warning. Sends that notifications to user mail in mobile devices Sends email alerts with detection details and images.

IV. METHODOLOGY

- **Requirement Analysis:** Gather system requirements based on security needs such as real-time monitoring, person detection, and alert mechanisms. Identify hardware and software components required, including camera modules, sensors, and the Raspberry Pi.
- **System Design:** Design the system architecture by creating block diagrams and flowcharts. Define how components like the camera, Raspberry Pi, and alert system interact. Plan the integration of machine learning models for person detection.
- **Implementation:** Develop the system using Python along with libraries such as OpenCV and TensorFlow/YOLO for computer vision. Configure the Raspberry Pi with the camera module and implement the detection and alert functionalities.
- **Testing:** Perform unit testing for individual modules (camera, detection, alerts), integration testing for combined components, and system testing to ensure real-time performance, accuracy, and reliability.

V. RESULT AND DISCUSSION

The AI-based Person Detection and Alert System is designed to monitor restricted areas using a camera and detect human presence in real time. The system uses a Raspberry Pi integrated with computer vision and AI models to analyze video input efficiently. When a person is detected, it instantly triggers alerts such as a buzzer, notifications, or email to ensure quick response. The system also stores detection data for future analysis and security tracking. This project can be easily deployed in classrooms or campus environments to enhance safety and automated monitoring.

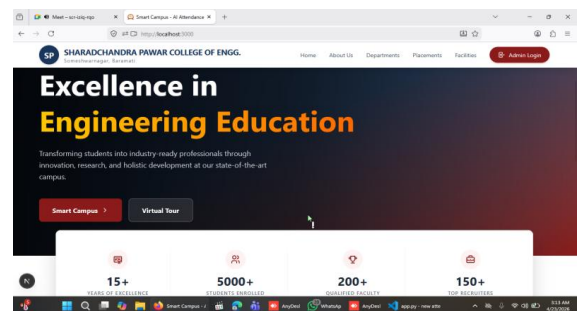


Fig: Home Page

This screen represents the login interface of a Smart Campus or AI-based system. It allows users such as administrators and students to securely access the platform using their email and password. The system includes features like captcha verification for security and a “Remember Me” option for convenience. Through this portal, authorized users can manage or monitor system activities such as attendance, person detection, and alerts. The interface is designed to be simple and user-friendly, ensuring smooth access to the system’s services.

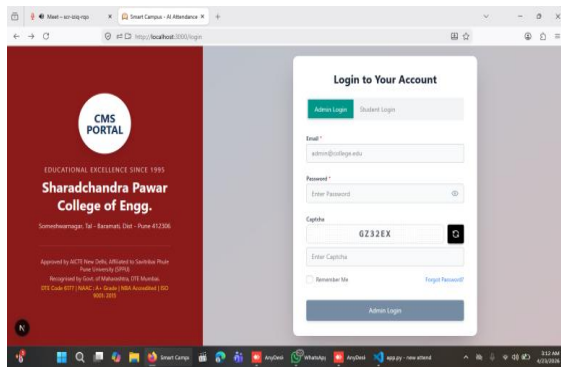


Fig: Login Interface

The system includes a database where all detected and stored information is presented in an organized manner. It shows details such as date, time, and captured images whenever a person is detected. This data is stored in a database and can be accessed through the user interface for monitoring and review. Users can easily track past detection records and analyze patterns of activity. This feature helps improve security management by providing clear and accessible records of all events.

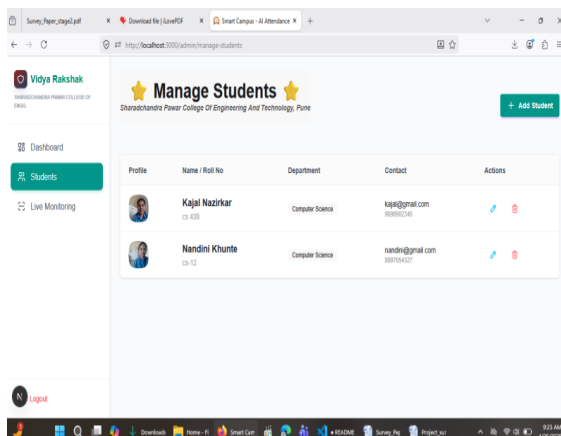


Fig: Database

The system ensures safe classroom entry by allowing only authorized students to be recognized through AI-based detection. When a student enters, the system verifies their identity using stored data and grants access smoothly. This helps maintain a secure and controlled classroom environment without manual checking. The system also records attendance automatically, saving time and effort. Overall, it improves safety and efficiency by managing student entry in a smart way.

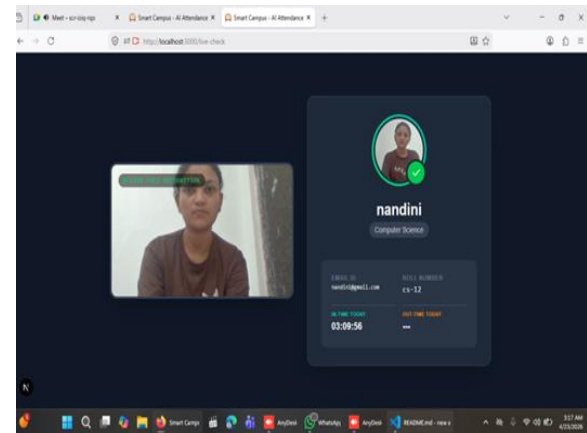


Fig:Authorized.Person

The system is designed to detect any unauthorized person entering the classroom and respond immediately. When an unknown individual is identified, the AI model triggers an alert through an email to inform the authorities. This helps prevent unwanted access and ensures the safety of students and staff. The system continuously monitors the area in real time for quick detection. Overall, it strengthens security by identifying and responding to Classroom unauthorized Not entry efficiently.

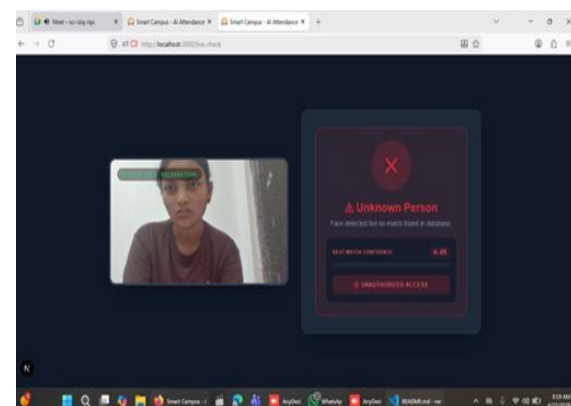


Fig:Unauthorized.Person

When an unauthorized person enters the classroom, the AI-based detection system immediately identifies that the person is not in the authorized database. The system then captures an image and records the time of the event. An alert is triggered, and an automatic Gmail notification is sent to the concerned authority with the details. This allows quick action to be taken for maintaining security. The feature ensures real-time monitoring and improves overall safety of the classroom environment.

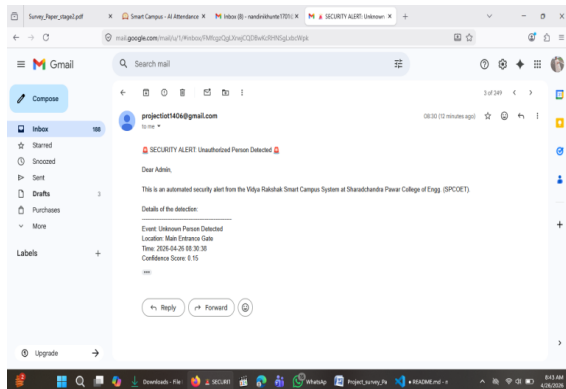


Fig:Alert.Mail

VI. APPLICATIONS

Security Systems: Provides real-time monitoring and from detects intruders in residential areas, ensuring safety Security through instant alerts.**Offices and Workplaces:** Monitors employee movement of and prevents unauthorized access to restricted areas.

Banks and ATMs: Enhances security by detecting the person suspicious activities and unauthorized persons around sensitive locations. **Hospitals and Healthcare Centers:** Ensures restricted access to sensitive areas like ICUs and labs.

Military and Defense Applications: Used for border surveillance and detection of intruders in high-security zones.

Parking Areas and Residential Societies: Monitors vehicle entry points and enhances security in gated communities

Educational Institutions: Ensures campus safety by monitoring entry and exit points and providing better control over student movement. **Classroom Security:** Allows only authorized students to enter and helps in maintaining a safe learning environment. **Industrial Security Systems:** Protects factories and industrial

areas by detecting entry and improving workplace safety. **Office and Workplace Monitoring:** Manages employee access and tracks attendance efficiently.

VII.CONCLUSION

The AI-based Person Detection and Alert System using Raspberry Pi provides an effective and intelligent solution for modern security challenges. The system enhances surveillance by automating the process of detecting human presence and generating real-time alerts, reducing the need for continuous manual monitoring.

By integrating computer vision and machine learning techniques, the system ensures accurate detection and quick response to potential threats. Features such as real-time monitoring, email notifications, and image capture improve overall reliability and usability. The use of low-cost hardware makes the system affordable and accessible for various applications, including homes, offices, and public spaces.

In the future, the system can be further enhanced by incorporating advanced technologies such as facial recognition, cloud-based storage, IoT integration, and mobile application support. These improvements will increase system efficiency, scalability, and intelligence.

VIII.FUTURE.WORK

In the future, the AI-based person detection and alert system can be improved by using advanced deep learning models to increase accuracy and reduce false detections. The system can be expanded to support multiple cameras for wider area coverage and better monitoring. Integration with mobile applications can provide real-time alerts and remote access to users. Additionally, features like face recognition and behavior analysis can be added to enhance security. These improvements will make the system more efficient, reliable, and suitable for large-scale deployment.

In the future, the system can be improved by using advanced AI models to increase detection accuracy and reduce errors. It can be expanded to support multiple cameras for covering larger areas effectively. Mobile application integration can provide real-time alerts and remote monitoring. Additional features like face recognition can further enhance identification and security. These improvements will make the system

more efficient, reliable, and suitable for wider use.

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