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AI-Enabled Smart Surveillance System For Detecting Harassment In Public Transport

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Abstract: *This paper presents the design and implementation of an AI-enabled smart surveillance system aimed at detecting harassment in public transport environments. The system utilizes a Raspberry Pi integrated with a camera module to perform real-time image processing using computer vision techniques such as motion detection and face detection. The system analyzes behavioral patterns and calculates a risk score based on suspicious activities. When the risk exceeds a predefined threshold, alerts are generated through a buzzer, OLED display, and Telegram notifications along with GPS location. The proposed system enhances public safety by providing automated monitoring, reducing human dependency, and enabling real-time response to critical situations.*

Keywords: *Smart Agriculture, IoT Scarecrow, ESP32, Automated Irrigation, PIR Sensor, Crop Protection, Web Dashboard.*

I. INTRODUCTION

With the rapid increase in safety concerns in public transport, there is a growing need for intelligent and automated surveillance systems. Traditional CCTV-based systems rely heavily on human monitoring, which is time-consuming and prone to errors. To overcome these limitations, this paper presents an AI-enabled smart surveillance system that uses computer vision techniques for real-time detection of suspicious activities. The system utilizes a Raspberry Pi and camera module to monitor the environment, analyze behaviour, and generate instant alerts in case of potential threats. This approach enhances public safety by providing faster response, reducing human effort, and enabling efficient monitoring.

II. LITERATURE SURVEY

Traditional surveillance systems based on CCTV require continuous human monitoring, which reduces efficiency and may lead to delayed responses. To overcome this, IoT-based systems were introduced that provide real-time monitoring and alerts using sensors and cameras, but they lack intelligent decision-making capabilities. Recent advancements focus on AI and computer vision techniques such as motion detection, face detection, and object recognition, which improve accuracy and automation. Systems using Raspberry Pi and OpenCV enable real-time image processing at low cost. However, existing solutions still face challenges like false alarms, high computational requirements, and dependency on internet connectivity.

III. PLATFORM TECHNOLOGY USED

This project integrates image sensing, intelligent data processing, and real-time alert mechanisms into a single embedded surveillance platform.

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• Microcontroller (Raspberry Pi):
Serves as the central processing unit of the system. It is selected for its sufficient processing power, GPIO support, and compatibility with Python and OpenCV libraries. It performs real-time image processing, decision-making, and controls all connected devices.

• Image Acquisition (Pi Camera Module):
A camera module is used to capture real-time images and video streams of the surroundings. It acts as the primary input device for the system, enabling computer vision operations such as motion detection and face detection.

• Intrusion Detection:
The system uses computer vision techniques such as motion detection and face detection instead of traditional sensors. Motion detection identifies any unusual movement, while face detection detects human presence and helps in behaviour analysis.

• Communication System (Wi-Fi / Telegram Bot):
The built-in Wi-Fi of Raspberry Pi is used for remote communication. A Telegram bot is integrated to send real-time alerts, including captured images and GPS location, to the user.

• Alert Mechanism:
A buzzer is used for audible alerts to notify nearby people instantly. An OLED display provides visual feedback by showing system status and risk level.

• Location Tracking (GPS Module):
A GPS module is used to obtain real-time location data. The location is sent along with alerts to help identify the exact position of the incident.

IV. PROBLEM STATEMENT

Manual monitoring in traditional surveillance systems often leads to delayed responses, as it depends heavily on continuous human observation. Basic motion detection systems also generate a high number of false alarms due to environmental changes such as lighting variations or non-threatening movements. Additionally, many existing systems lack intelligent behavior analysis, making it difficult to accurately identify real threats. Some solutions are highly dependent on internet connectivity, which can limit their effectiveness in areas with poor network access. Furthermore, issues related to data privacy and the high cost of advanced surveillance systems pose significant challenges for widespread adoption.

V. AIM AND OBJECTIVES

The aim of this project is to develop an AI-enabled smart surveillance system that can monitor surroundings in real time and detect suspicious activities automatically to enhance public safety. The main objectives include implementing motion and face detection using computer vision techniques, analysing behaviour to determine risk levels, generating real-time alerts through buzzer and Telegram notifications, and designing a low-cost, efficient system that reduces.

VI. DIAGRAM

A) Block Diagram

The block diagram of the AI-enabled smart surveillance system represents the overall flow of data and interaction between different components. The system begins with the camera module, which continuously captures real-time images or video of the surrounding environment. These images are then sent to the Raspberry Pi, which acts as the central processing unit.

The Raspberry Pi processes the captured data using computer vision techniques such as motion detection and face detection to analyze activities and identify any suspicious behavior. Based on this analysis, the system calculates a risk level to determine whether the situation is normal or potentially dangerous.

If no abnormal activity is detected, the system continues monitoring in normal mode. However, if a threat is identified, the system activates multiple alert mechanisms. A buzzer is triggered to provide an immediate audible alert, while an OLED display shows the system status and risk level. At the same time, a notification along with the captured image and GPS location is sent to the user via a Telegram bot.
Thus, the block diagram explains how input (camera data) is processed and converted into intelligent output actions (alerts and notifications), making the system efficient and automated.

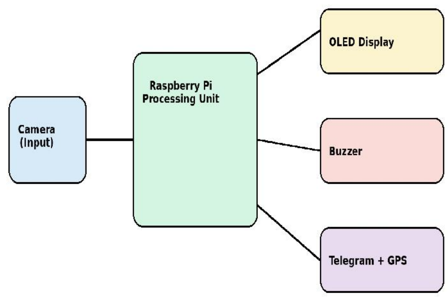
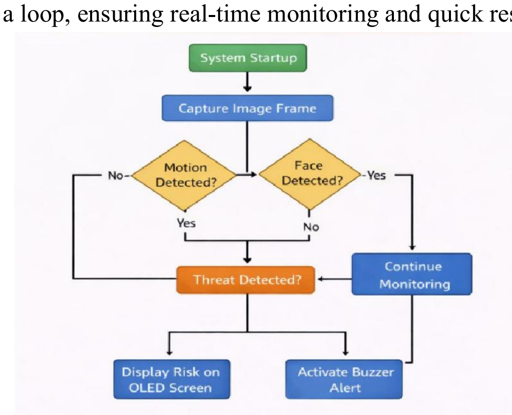


Fig. 1. System Block Diagram.

B) Flow Chart

The flow chart of the system represents the step-by-step working process of the surveillance system. It begins with system initialization, where all components such as the camera, Raspberry Pi, and sensors are activated. The camera continuously captures real-time images, which are processed by the Raspberry Pi.
The system then performs motion detection and face detection to analyze the captured data. Based on this analysis, a risk level is calculated. If no suspicious activity is detected, the system continues monitoring. However, if the risk level exceeds a predefined threshold, the system triggers alerts such as activating the buzzer, displaying messages on the OLED screen, and sending notifications with image and GPS location via Telegram.
This process runs continuously in a loop, ensuring real-time monitoring and quick response to potential threats



.Fig. 2. Software Flow Chart

The circuit diagram of the AI-enabled smart surveillance system shows the interconnection of all hardware components with the Raspberry Pi, which acts as the main controller. The Pi Camera is connected through the CSI interface to

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capture real-time images. The OLED display is interfaced using the I2C communication protocol (SDA and SCL pins) to display system status and alerts.

A buzzer is connected to a GPIO pin to provide an audible alert when a threat is detected. The GPS module is connected via UART (TX and RX pins) to provide real-time location data. All components are powered using a regulated 5V power supply, and a common ground is maintained to ensure stable operation.

Thus, the circuit diagram illustrates how input devices, processing unit, and output components are electrically connected to achieve efficient system functionality.

VII. COMPONENTS / MATERIALS

The system is constructed using reliable electronic modules suitable for real-time monitoring and surveillance applications.

• Raspberry Pi (Microcontroller):

The central brain of the system. It processes image data, executes AI-based algorithms such as motion detection and face detection, and controls all connected components. It also manages communication and alert generation.

• Pi Camera Module:

Used to capture real-time images and video of the surroundings. It provides input data for computer vision processing and enables detection of

motion and human presence.

• Intrusion Detection (Software-Based):

Instead of physical sensors, the system uses computer vision techniques like motion detection and face detection implemented through OpenCV. These methods help in identifying suspicious activities and human interaction.

• GPS Module:

Provides real-time location data (latitude and longitude). This information is sent along with alert notifications to help track the exact location of the incident.

• OLED Display (I2C):

Displays system status, detected activity, and risk level in real time. It provides clear visual feedback to the user without requiring external devices.

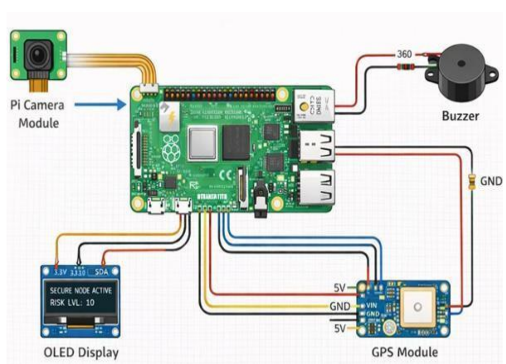

Fig. 3. Circuit Diagram.

• Buzzer (Alert System):

Acts as an audible alert mechanism. It produces sound when suspicious activity is detected, helping to notify nearby individuals instantly.

• Power Supply (5V):

Provides stable and regulated power to the Raspberry Pi and all connected components, ensuring continuous and reliable system operation.

• Communication Module (Wi-Fi / Telegram):

Uses the built-in Wi-Fi of Raspberry Pi to send real-time alerts. Telegram bot integration allows remote monitoring by sending messages, images, and GPS location to the user.

VIII. WORKING

The AI-enabled surveillance system operates through a continuous and intelligent software loop to ensure real-time monitoring and alert generation:

• System Initialization:

The Raspberry Pi boots up, initializes the camera module, OLED display, buzzer, and communication modules. It connects to the predefined Wi-Fi network and prepares the system for real-time monitoring.

• Data Acquisition:

The Pi Camera continuously captures real-time images or video frames of the surroundings. These frames are sent to the Raspberry Pi for further processing.

• Image Processing:

The captured frames are processed using OpenCV. The system performs motion detection to identify any movement and face detection to detect human presence in the scene.

• Behaviour Analysis:

The system analyses detected motion and faces to determine interaction patterns. Based on factors such as multiple persons, movement intensity, and abnormal behaviour, it evaluates the situation.

• Risk Evaluation:

A risk score is calculated based on the analysed data. If the activity is normal, the system remains in monitoring mode. If suspicious behaviour is detected, the risk level increases.

• Alert Mechanism:

When the risk level exceeds a predefined threshold, the system activates the buzzer for an immediate audible alert and updates the OLED display with warning messages and risk status.

• Notification System:

The system sends real-time alerts to the user via a Telegram bot, including captured images and GPS location details for remote monitoring and quick response.

• Continuous Monitoring:

The entire process runs continuously in a loop, ensuring uninterrupted surveillance, quick detection of threats, and timely alert generation.

IX. RESULTS

The developed surveillance system prototype was tested under different real-time conditions to evaluate its performance and reliability.

• Intrusion Detection:

The system effectively detected motion and human presence using computer vision techniques. Motion detection and face detection algorithms worked accurately, minimizing false alerts caused by environmental changes such as lighting variations or minor movements.

• Risk Analysis and Alert System:

The system successfully analysed detected activities and calculated risk levels. When suspicious behaviour was identified, it triggered alerts instantly by activating the buzzer and displaying warning messages on the OLED screen.

• Real-Time Notification:

The Raspberry Pi successfully sent alert notifications through the Telegram bot, including captured images and GPS location. The communication was reliable and ensured quick remote monitoring.

• System Performance:
The overall system operated smoothly with fast response time and continuous monitoring. The integration of AI-based processing and embedded hardware proved effective in providing a reliable and efficient smart surveillance solution.

X. ADVANTAGES & APPLICATIONS

ADVANTAGES

• Real-Time Monitoring: The system continuously monitors the environment and detects suspicious activities instantly, ensuring quick response.
• Automated Surveillance: Reduces the need for manual monitoring by using AI-based motion and face detection for intelligent decision-making.
• Enhanced Safety: Provides immediate alerts through buzzer, OLED display, and Telegram notifications, improving security in critical situations.
• Low-Cost Implementation: Uses cost-effective components like Raspberry Pi, making it affordable and accessible for various applications.
• Remote Accessibility: Users can monitor and receive alerts with images and location details on their smartphones from anywhere.

APPLICATIONS

• Public Transport Safety: Helps in detecting harassment or suspicious activities in buses, trains, and other public transport systems.
• Women Safety Systems: Provides real-time alerts and monitoring to enhance personal safety in public spaces.
• Home and Office Security: Can be used for monitoring unauthorized access and ensuring safety of property and individuals.
• Public Place Surveillance: Useful in areas like railway stations, streets, malls, and parking areas for improved security.
• Smart City Applications: Can be integrated into smart city infrastructure for automated and intelligent monitoring systems.

XI. FUTURE SCOPE

• Advanced Face Recognition Integration:
The system can be upgraded with face recognition technology to identify authorized and unauthorized individuals more accurately, improving security in sensitive areas.
• Cloud Storage Integration:
Captured images and videos can be stored on cloud platforms for secure backup and remote access, enabling better data management and analysis.
• Mobile Application Development:
A dedicated mobile application can be developed to provide a user-friendly interface for monitoring, receiving alerts, and controlling the system.
• IoT and Long-Range Communication:
Technologies like GSM, LoRa, or NB-IoT can be integrated to send alerts in areas with limited Wi-Fi connectivity, ensuring reliable communication.

XII. CONCLUSION

The AI-enabled smart surveillance system presents an efficient and intelligent solution for modern security challenges. By integrating Raspberry Pi, camera module, and computer vision techniques, the system enables real-time monitoring and automatic detection of suspicious activities. The implementation of motion detection, face detection, and risk analysis improves accuracy and reduces human dependency.

The system successfully generates instant alerts through buzzer, OLED display, and Telegram notifications along with image and GPS location, ensuring quick response. It is cost-effective, easy to implement, and suitable for various applications such as public transport safety, home security, and smart city surveillance.

Overall, the proposed system demonstrates the effective use of Artificial Intelligence and embedded systems in enhancing safety and provides a strong foundation for future advancements in smart surveillance technologies.

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