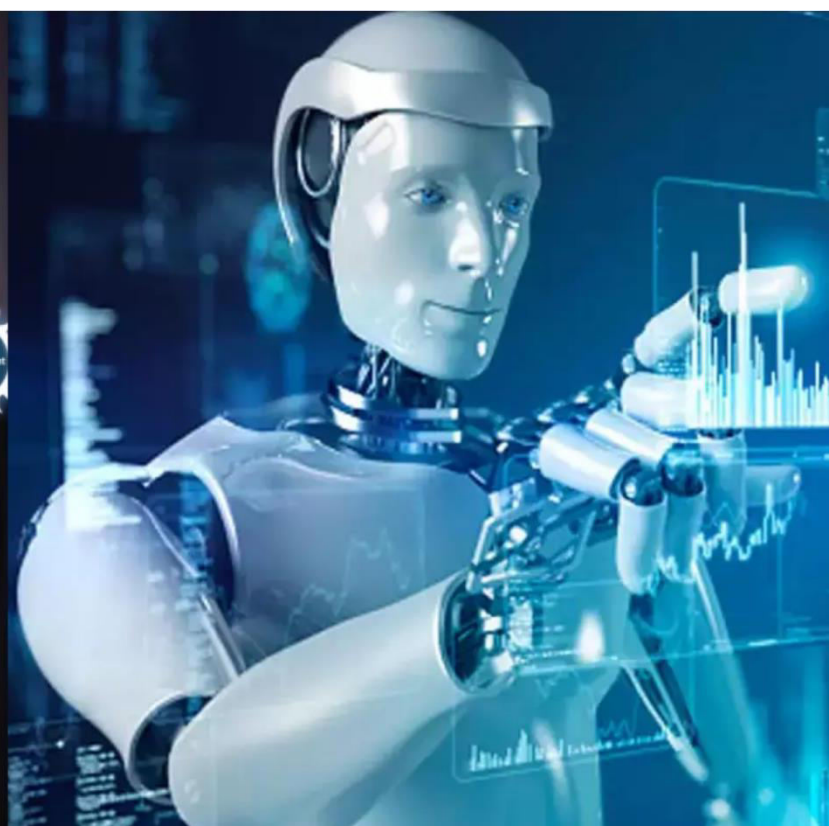




International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 9.935

Volume 15, Issue 8, August 2026

Raspberry Pi Based Security Surveillance Robot with Face Recognition

Dr. Kiran Kumar G H, Siddesh Chikkol C T, V Udaykiran, Yashawantha Gowda N P, Veeresh G S

Associate Professor, Dept. of ECE, Bapuji Institute of Engineering and Technology, Davangere, Karnataka, India

UG Student, Dept. of ECE, Bapuji Institute of Engineering and Technology, Davangere, Karnataka, India

ABSTRACT: The Raspberry Pi Pico-Based Patrolling Robot is a cloud-assisted, remotely controlled surveillance system designed to enhance security monitoring and emergency response in various environments such as homes, offices, and industrial sites. This project aims to develop an intelligent mobile robot equipped with essential security features including gas detection, fire detection, human motion detection, live video streaming, and an emergency alert system. The robot is powered by a Raspberry Pi Pico, which serves as the local controller for all hardware components, while cloud integration facilitates real-time event logging, data storage, and remote monitoring through a web-based dashboard.

KEYWORDS: Surveillance; Raspberry Pi; Face Recognition; Telegram Alert System

I. INTRODUCTION

The Raspberry Pi Pico-Based Patrolling Robot is a cloud-assisted, remotely controlled surveillance system designed to enhance security monitoring and emergency response in various environments such as homes, offices, and industrial sites. This project aims to develop an intelligent mobile robot equipped with essential security features including gas detection, fire detection, human motion detection, live video streaming, and an emergency alert system. The robot is powered by a Raspberry Pi Pico, which serves as the local controller for all hardware components, while cloud integration facilitates real-time event logging, data storage, and remote monitoring through a web-based dashboard.

The Raspberry Pi Pico-Based Patrolling Robot is a cloud-assisted, remotely controlled surveillance system designed to enhance security monitoring and emergency response in various environments such as homes, offices, and industrial sites. This project aims to develop an intelligent mobile robot equipped with essential security features including gas detection, fire detection, human motion detection, live video streaming, and an emergency alert system. The robot is powered by a Raspberry Pi Pico, which serves as the local controller for all hardware components, while cloud integration facilitates real-time event logging, data storage, and remote monitoring through a web-based dashboard.

II. RELATED WORK

FLOW CHART OF SURVEILLANCE ROBOT

The Raspberry Pi-based security surveillance robot system begins with the activation of all connected sensors once it is powered on. These sensors may include face recognition modules, flame detectors, gas sensors, and human detection systems. After the sensors are activated, the robot connects to a web interface, which serves as a control panel for the user. From this web interface, the user can choose between two operating modes: Auto Control or Manual Control as shown in fig 1.

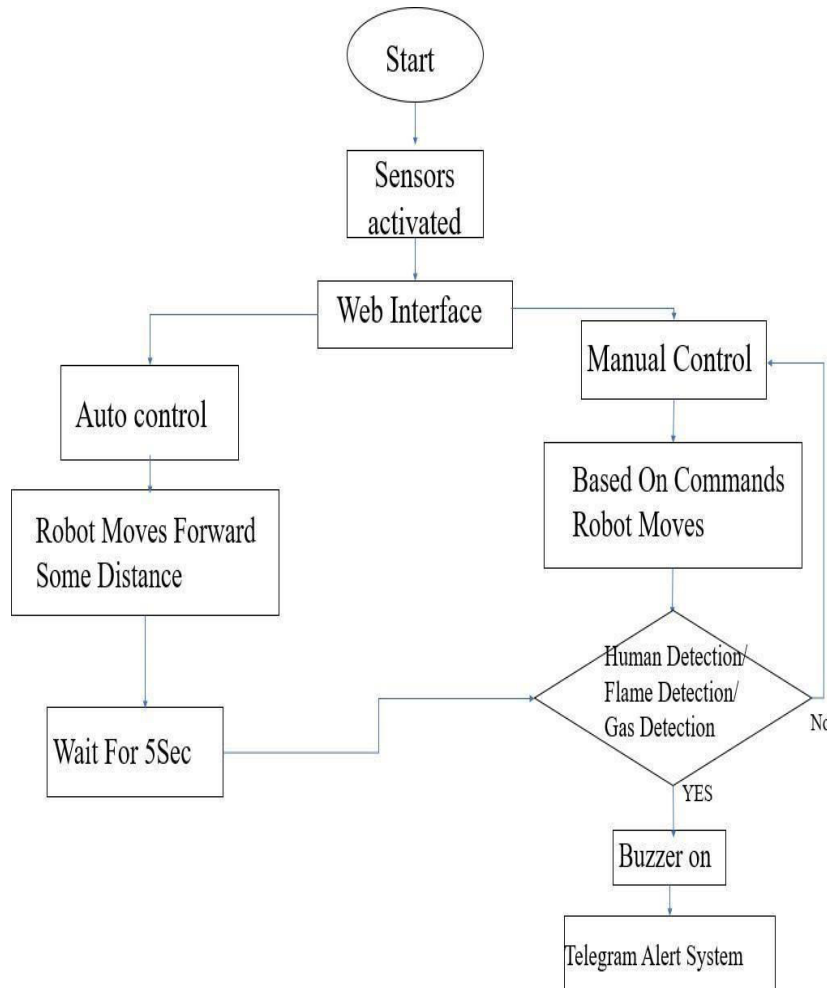


Fig 1 Flow Chart of Working of Surveillance Robot

In Auto Control mode, the robot operates independently. It moves forward by a certain distance without user intervention and then pauses for five seconds. This pause allows the robot to monitor its surroundings using the activated sensors. After this, it checks for any critical detections such as human presence (especially unauthorized), fire through flame detection, or the presence of dangerous gases. If any of these conditions are met, the system triggers a buzzer to alert people nearby and also sends an alert through the Telegram application, notifying the user remotely.

Alternatively, the robot can be operated in Manual Control mode. In this case, the user directly controls the robot's movement via commands given through the web interface. This mode is useful for targeted inspections or in areas where autonomous navigation may not be reliable. While in manual control, the robot still monitors the environment using its sensors. If it detects a human, flame, or gas, the same alert mechanism is triggered—buzzer activation and Telegram notification.

If no threats are detected, whether in auto or manual mode, the robot continues to operate in its selected mode, repeating the detection process to ensure continuous surveillance. This system combines automation with remote control and alerting capabilities, making it suitable for real-time security monitoring using Raspberry Pi and smart sensors.

III. ARCHITECTURE OF SURVEILLANCE ROBOT

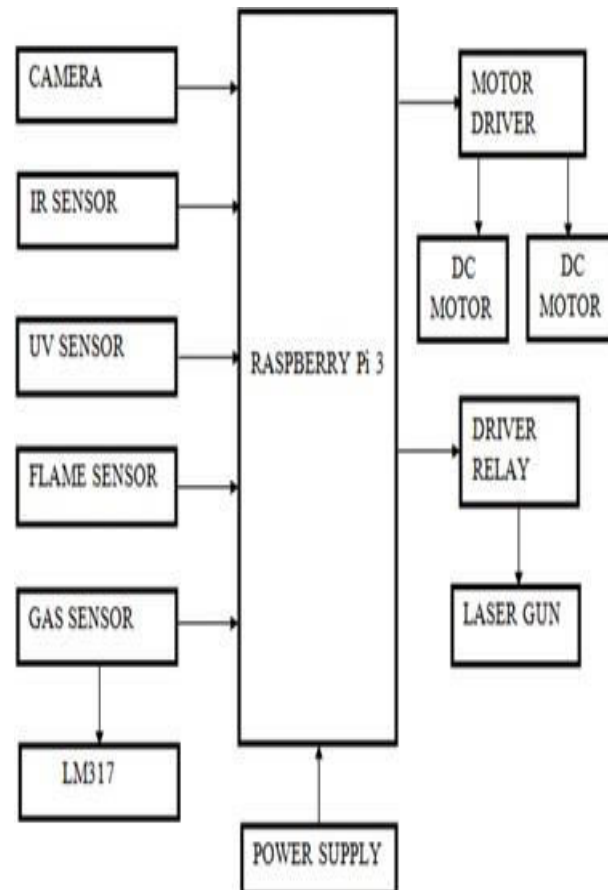


Fig. 2: Block diagram of surveillance robot

A Raspberry Pi Pico-based security surveillance robot with Face Recognition designed to perform gas and flame sensing, face recognition, and real-time alert generation. At the core of the system is the Raspberry Pi Pico, which controls all the components and manages sensor data. A camera module is used for capturing images and performing face recognition to identify intruders or authorized personnel. Camera detects movement in the monitored area and and alert system. A gas sensor monitors air quality and detects harmful gases, while a flame sensor (referred to as the “Fiazo Sensor”) identifies the presence of fire. When a threat is detected, a piezo buzzer is triggered to alert nearby individuals. The robot’s movement is powered by two DC motors controlled through a motor driver (L298N), enabling it to patrol an area. A lithium-ion battery supplies power to the entire system, ensuring mobile operation. This integrated setup makes the robot suitable for autonomous surveillance and safety monitoring in various environments.

A key feature of this system is real-time alert communication through a Telegram bot. The Raspberry Pi Pico (or an external Wi-Fi module like ESP32 is added) can be programmed to interface with the Telegram Bot API. When a sensor is triggered or an event occurs (like gas detection, flame presence or unauthorized face recognition), the system sends an automated alert message to a predefined Telegram chat. These alerts can include text messages, sensor status updates, captured images, and timestamps. This functionality allows remote monitoring of the robot’s activity and environment from a smartphone or computer, regardless of the user’s location.

Integrating Telegram makes the system smarter and more responsive, as users can receive live notifications, issue commands, and. This significantly enhances the usability and effectiveness of the surveillance system in real-world scenarios like smart homes, military zones, warehouses, and high-security offices as shown in fig 2.

IV. WEB BASED DASHBOARD

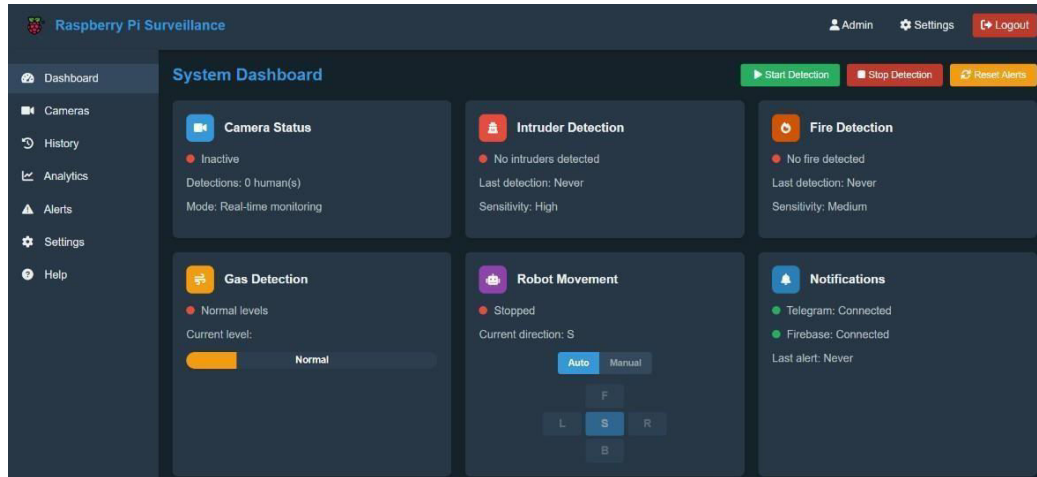


Fig. 3: Web Dashboard

The web-based dashboard acts as a central control panel for users to interact with the security surveillance robot remotely. Built using frontend technologies like HTML5, CSS3, and JavaScript (with frameworks such as React.js or Vue.js), it allows users to view live video, monitor sensor data, and control robot movements. The backend is powered by Flask, a Python framework that manages HTTP requests and real-time communication via Web Sockets. Sensor data is stored and retrieved from cloud databases like Firebase or AWS, and live video is streamed using OpenCV integrated with Flask. For notifications, services like Web Push or Firebase Cloud Messaging are used to alert users on mobile or desktop platforms as shown in fig 3.

Through this dashboard, users can move the robot in any direction using virtual controls, view a live camera feed, and monitor critical sensors such as gas, flame, and motion detectors. It also displays alerts during emergencies like gas leaks or fire, notifying users instantly and allowing quick decision-making. Additionally, users can manually control the buzzer, either activating it during tests or turning it off in case of false alarms. This user-friendly interface significantly enhances the functionality and accessibility of the surveillance system, allowing real-time control and monitoring from anywhere.

V. VIDEO STREAMING AND IMAGE PROCESSING

The video streaming and image processing system in the surveillance robot uses OpenCV and Flask to provide real-time visual monitoring. OpenCV is responsible for capturing video from the 5MP camera module and processing it as required, such as adjusting resolution or detecting motion. This video feed is then transmitted to the Flask server, which serves it over HTTP to be displayed on the web dashboard. This allows the user to monitor the robot's environment live from a remote location as shown in fig 4.

Flask also handles additional requests, such as starting or stopping the video feed and capturing still images during key events. These snapshots can be logged for later review, enhancing the security documentation of the system. Together, Flask and OpenCV create a smooth and responsive video experience for users while supporting key image logging functionality in the robot's operation.

Face Detection

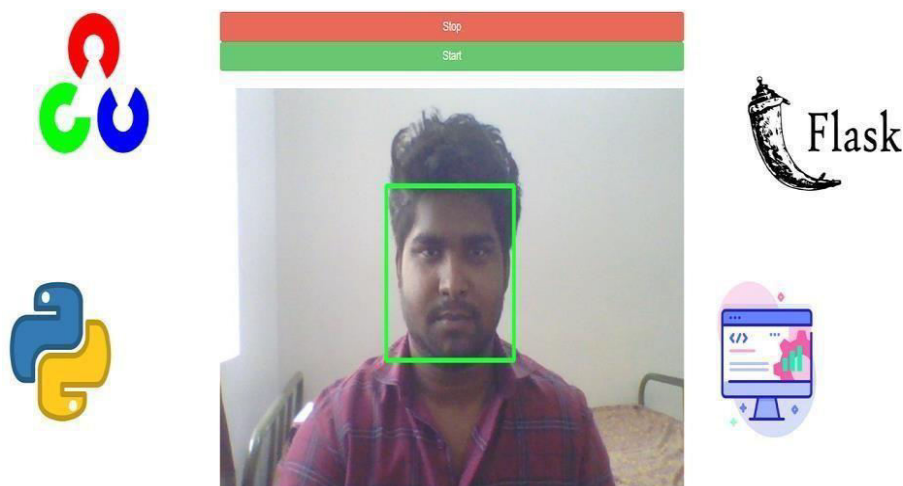


Fig. 4: Face Detection

VI. RESULTS AND DISCUSSION

MQ-2 Gas Sensor

The MQ-2 sensor accurately detects gas concentrations like LPG and smoke. It triggered alerts when the gas threshold exceeded safe limits, ensuring timely warnings for potential leaks.

Flame Sensor

The flame sensor reliably identified fire or heat sources within its range. During testing, it responded instantly to flame exposure, activating the buzzer and sending real-time alerts.

PIR Motion Sensor

The PIR sensor effectively detected human movement. It minimized false positives by adjusting sensitivity and performed well in both indoor and outdoor settings.

Camera Module with Face Recognition

The camera module integrated with OpenCV successfully recognized known faces and flagged unknown individuals. Recognition accuracy improved under good lighting conditions, enhancing surveillance as shown in fig 5.

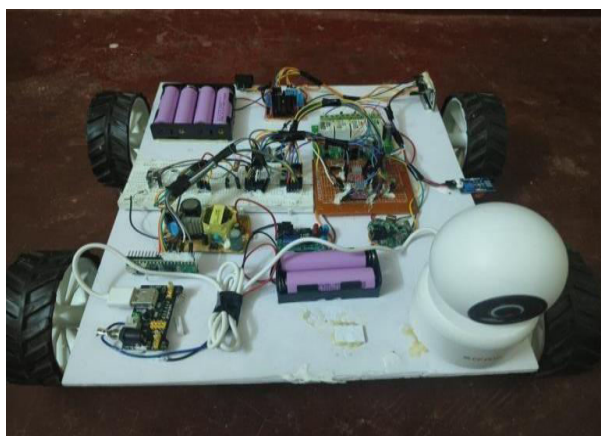


Fig. 5: Prototype of Surveillance robot

VII. TELEGRAM ALERT SYSTEM

The Telegram Alert System was implemented to provide real-time emergency notifications via the Telegram messaging platform. During testing, the system successfully sent alerts to the configured Telegram bot when the sensors (gas, flame, or motion) detected anomalies as shown in fig 6 & 7.

Messages were delivered instantly and reliably to the user's Telegram account, even on low- bandwidth connections. This ensured that users could monitor and respond to emergencies from any location using a smartphone, enhancing the accessibility and effectiveness of the overall security solution.



Fig. 6: Human Detection



Fig. 7: Fire Detection

VIII. CONCLUSION AND FUTURE SCOPE

The Raspberry Pi Pico-based security surveillance robot with face recognition offers a compact, cost-effective, and intelligent solution for real-time security monitoring. By integrating various sensors such as gas, flame, and PIR motion detectors, the system ensures a comprehensive approach to detecting environmental threats and unauthorized access. The addition of face recognition significantly enhances identification accuracy, enabling targeted responses rather than relying solely on motion detection.

The use of cloud communication, a web-based dashboard, and Telegram alerts ensures that users can remotely monitor and control the robot from anywhere, providing flexibility and convenience. The integration of video streaming using OpenCV allows for real-time visuals, while automation and sensor-driven responses ensure quick action during emergencies. The entire system demonstrates the capability of microcontrollers like the Raspberry Pi Pico in real-world surveillance applications.

In conclusion, this project showcases a robust and scalable solution for modern surveillance needs. Its modular architecture allows for easy upgrades, such as integrating AI-driven analytics, GPS tracking, or enhanced power management. With further development, it holds potential for deployment in residential, commercial, and public security systems, contributing to a safer and smarter environment

IX. FUTURE SCOPE

- a) Enhanced AI and Face Recognition Accuracy
 - Future models can integrate advanced AI algorithms to improve face detection and recognition accuracy.
 - Implementation of machine learning can help the system adapt and recognize new faces over time.
- b) Integration with Smart Home and IoT Systems
 - The robot can be integrated with smart door locks, lights, and alarm systems for a more automated response.
 - Voice assistants like Alexa or Google Assistant can be linked for remote control.
- c) Autonomous Navigation and Patrol
 - By using sensors like LiDAR or GPS, the robot can autonomously patrol larger areas without manual control.
 - Path planning and obstacle avoidance can make surveillance more efficient.
- d) Cloud-Based Data Analytics
 - Collected surveillance data can be analyzed in the cloud for identifying patterns or security risks.
 - Data logs can be used for forensic analysis or improving system efficiency.
- e) Low-Power Operation and Solar Charging
 - Adding solar panels and optimizing power consumption will allow longer field deployment without frequent recharging.
 - Smart sleep/wake cycles can reduce energy use during idle periods.
- f) Multi-Robot Surveillance Systems
 - Multiple robots can be networked together to cover large areas like campuses, industrial zones, or farms.
 - Coordination between robots will enhance area coverage and reduce blind spots.



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details