

SURVEILLANCE ROBOT WITH FACE RECOGNITION

Ms. Dnyaneshwari Patil*1, Mr. Sanket Chindake*2, Mr. Amit Chavan*3, Ms. Lata S. Patil *4, Prof. Ms. S. V. Solapure*5

*1,2,3,4 Student of Dept of ECS, Dr. A. D. Shinde Collage of Engineering, Bhadgaon, India. *5 Assistant Professor in ECS Dept, Dr. A. D. Shinde Collage of Engineering, Bhadgaon, India.

ABSTRACT: This paper presents a Wireless Surveillance Robot with Real-Time Face Detection designed for remote monitoring and security applications. The system uses an ESP32 and NRF24L01 for wireless control, while a Raspberry Pi Zero 2W processes commands and controls robot movement. A Raspberry Pi Camera Module v2 mounted on a servo motor provides live video streaming with a wider field of view. The system uses OpenCV for real-time face detection and identification. Developed using Python and embedded technologies, the robot offers reliable control, stable video transmission, and efficient surveillance, making it suitable for security and remote monitoring applications.

I. INTRODUCTION

The convergence of embedded computing, wireless communication, and computer vision technologies has significantly accelerated the development of intelligent robotic systems. These advancements have enabled the creation of surveillance platforms that can operate either autonomously or under human supervision. Such systems are increasingly important in modern security applications where real-time monitoring and adaptability are required.

Traditional closed-circuit television (CCTV) systems, although widely used, have certain limitations. They rely on fixed camera installations, which restrict their field of view and make them less effective in dynamic or large environments. Since they lack mobility, they cannot respond to changing situations or track moving objects efficiently, reducing their overall effectiveness in advanced surveillance scenarios.

To overcome these limitations, mobile surveillance robots have emerged as a practical solution. These robots combine physical mobility with intelligent sensing, allowing them to navigate through different environments while capturing and transmitting data. By integrating wireless communication, they enable remote monitoring and control, providing greater flexibility and coverage compared to conventional surveillance systems.

II. LITERATURE SURVEY FOR PROBLEM IDENTIFICATION AND SPECIFICATION

Literature Survey

1. Raspberry Pi Based Smart Surveillance System

Authors: Various Researchers in Embedded Systems

Published In: IEEE Embedded Systems and Robotics Journals

This paper discusses surveillance systems developed using Raspberry Pi for real-time video monitoring and image processing. These systems use cameras and wireless communication modules to stream live video and perform basic object or face detection, providing a low-cost and efficient security solution.

2. Face Detection Using OpenCV in Embedded Systems

Authors: Computer Vision Researchers

Published In: IEEE Image Processing and AI Journals

This paper explains face detection techniques implemented using OpenCV in embedded platforms. The study highlights the use of Haar Cascade classifiers for real-time face detection, offering accurate human identification with low computational requirements, making it suitable for smart surveillance applications.

Project Objectives

The system plays an important role in improving modern surveillance and security monitoring. The main objectives are as follows:

1. The primary objective is to develop a wireless surveillance robot with real-time face detection for intelligent monitoring applications.
2. To provide a simple, efficient, and low-cost solution for remote surveillance and area inspection.
3. To improve security by enabling live video streaming and automatic face detection in real time.
4. To establish wireless communication and remote control for smooth robot movement and monitoring.
5. To create a foundation for future enhancements such as face recognition, autonomous navigation, and smart alert systems.

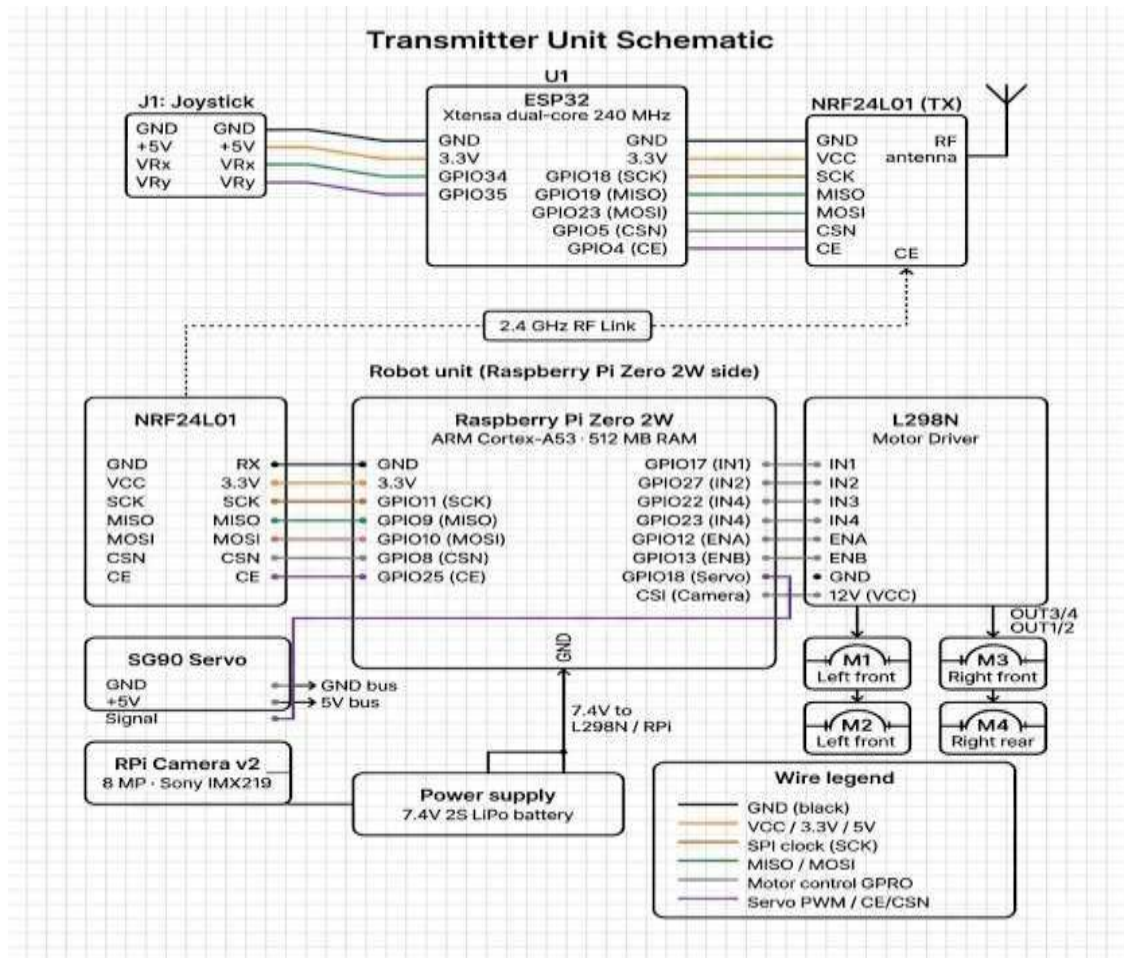
III. WORKING

A Wireless Surveillance Robot with Real-Time Face Detection enables users to monitor and control a robotic surveillance system remotely, making security monitoring more flexible, intelligent, and efficient than traditional fixed camera systems. Control commands are provided through a joystick module connected to the ESP32, which processes the input and wirelessly transmits movement instructions using the NRF24L01 communication module.

Once the commands are received, the Raspberry Pi Zero 2W processes them and controls the robot's movement through the L298N, allowing the robot to move in different directions. At the same time, the Raspberry Pi Camera Module v2 continuously captures live video and streams it over Wi-Fi, enabling remote monitoring through a web browser.

The captured video is processed using OpenCV for real-time face detection. The system identifies human faces in the video stream and highlights them, improving situational awareness and surveillance efficiency. This combination of wireless control, live streaming, and intelligent face detection creates an effective and user-friendly monitoring system for security and remote inspection applications.

IV. BLOCK DIAGRAM WITH CONNECTION DIAGRAM



V. EXPECTED RESULT

The robot is expected to perform the following actions:

- Wireless Movement Control:**

The robot responds to joystick inputs such as forward, backward, left, right, and stop. Based on these commands, the L298N activates the DC motors, enabling smooth directional movement of the robot.

- Live Video Monitoring:**

The system captures real-time video using the Raspberry Pi Camera Module v2 and streams it over Wi-Fi through a web browser, allowing remote surveillance and monitoring.

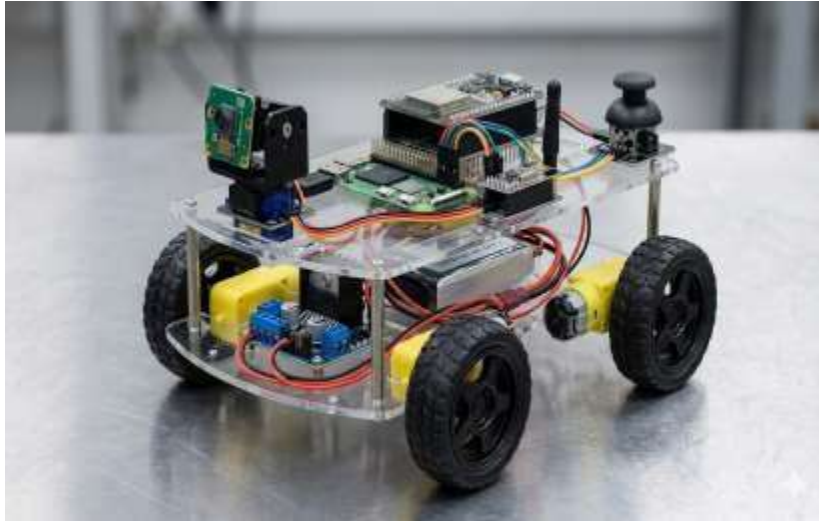
- Face Detection:**

Using OpenCV, the system performs real-time face detection. When a human face is identified, it highlights the face in the video stream, improving monitoring and situational awareness.

- **Real-Time Performance:**

All functions, including wireless control, video streaming, and face detection, are expected to operate with minimal delay, ensuring smooth and efficient surveillance performance.

VI. PROJECT SNAPSHOT



VII. CONCLUSION

This project successfully presents a Wireless Surveillance Robot with Real-Time Face Detection for smart monitoring applications. The system combines ESP32, NRF24L01, and Raspberry Pi Zero 2W to achieve wireless control, live video streaming, and real-time face detection using OpenCV. The robot provides reliable movement, wide camera coverage, and efficient monitoring capabilities. Overall, the system offers a low-cost, practical, and scalable solution for security surveillance and remote monitoring applications.

VII. REFERENCE

- [1] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR), 2001.
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- [3] Nordic Semiconductor, "nRF24L01+ Single Chip 2.4GHz Transceiver Product Specification," Rev 1.0, 2008.
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