Project : ESP32-CAM Surveillance Rover

Team Member

Md. Shahrier Islam Asif   011 231 0319

Contents

1   Abstract

The ESP32-CAM Surveillance Rover is a mobile robot car equipped with a camera module that provides live video streaming and remote navigation. By integrating additional sensors—ultrasonic for obstacle detection, gas/smoke for safety, and light for ambient monitoring—the rover can intelligently navigate and monitor its environment. Users can control and monitor the rover directly through a web browser without the need for external applications. The system is lightweight, portable, and battery-powered, making it suitable for DIY home security, environmental monitoring, and educational robotics projects.

2   Project Overview

This project aims to design and build a smart surveillance rover using the ESP32-CAM module as the central controller. The rover will stream live video, accept movement commands via a web interface, and monitor its environment using sensors.

- Ultrasonic sensor ensures safe navigation by detecting obstacles.

- Gas/Smoke sensor provides safety alerts for hazardous conditions.

- Light sensor monitors ambient lighting and can trigger notifications or adjust operation.

3   Components List

1. ESP32-CAM Module (OV2640 camera)

2. Robot Car Chassis with DC Gear Motors & Wheels

3. Motor Driver Module (L298N / TB6612FNG)

4. Battery Pack (Rechargeable, e.g., Li-ion / LiPo)

5. Voltage Regulator / Power Module (if required)

6. USB-to-TTL Programmer (FTDI / CP2102)

7. Jumper Wires & Connectors

8. MicroSD Card (Optional)

9. Mounting Hardware (Screws, Standoffs, Tape)

10. Optional Add-ons (LEDs / Buzzer)

11. Ultrasonic Sensor (HC-SR04)

12. Gas/Smoke Sensor (MQ-2 / MQ-135)
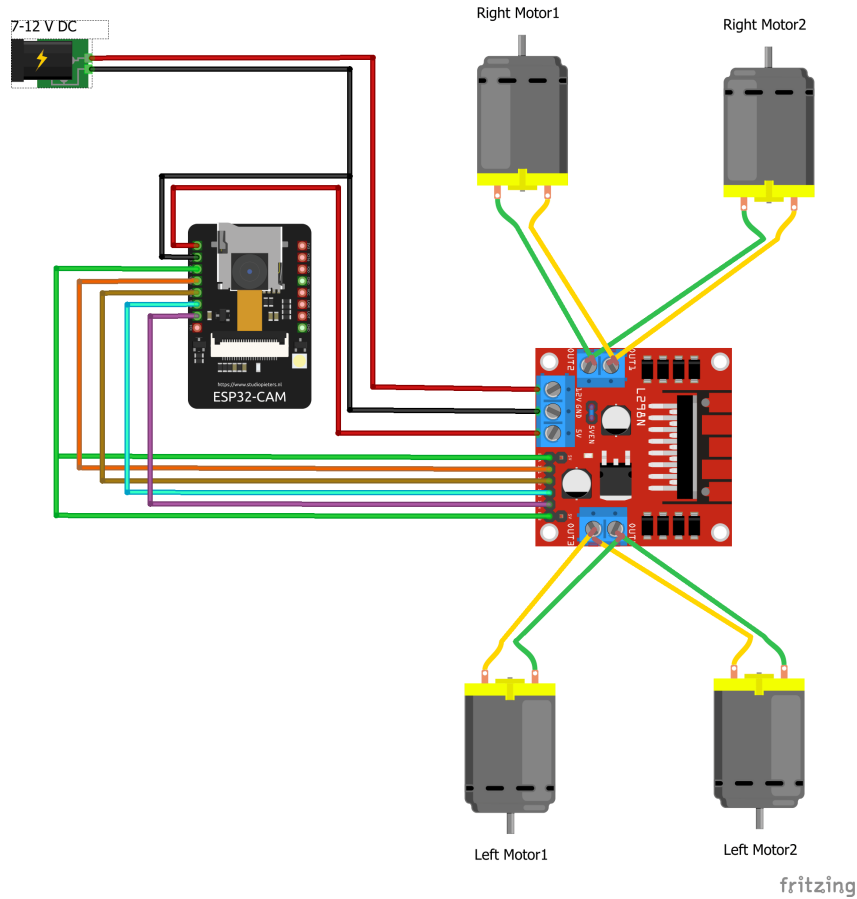
13. Light Sensor (LDR / Photocell)

Figure 1: Overall Rover Diagram

4 Component List and Purposes

4.1 ESP32-CAM Module (OV2640 camera included)

Figure 2: ESP32-CAM Module
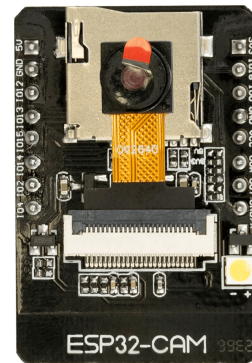
It acts as the main controller of the rover, provides Wi-Fi connectivity for hosting the web interface, streams live video feed directly to the browser, and also sends GPIO signals to the motor driver while reading sensor data.

4.2   Robot Car Chassis with DC Gear Motors & Wheels

This provides the mechanical body of the rover, allows movement in forward, backward, left, and right directions using DC motors, and offers physical support for all the mounted components through its wheels and frame.

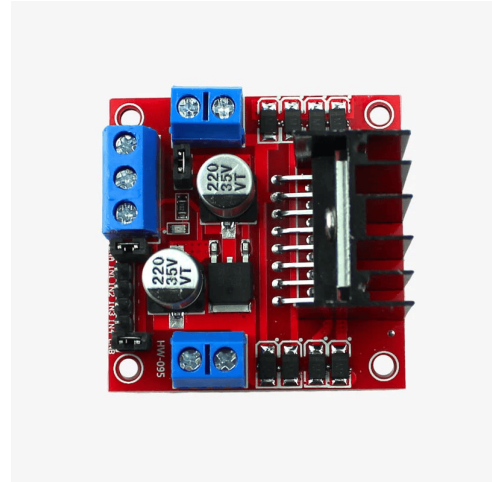## 4.3   Motor Driver Module (e.g., L298N / TB6612FNG)

Figure 3: Motor Driver Module

It works as the interface between the ESP32-CAM and the motors, receives low-power control signals from the ESP32, delivers enough current to drive the motors, and protects the controller from high motor currents and back-EMF.

4.4   Battery Pack (Rechargeable, e.g., Li-ion / LiPo)

The battery pack supplies portable power to the ESP32-CAM, motors, and sensors, ensuring the rover's mobility without depending on external adapters.

4.5   Voltage Regulator (5V / 3.3V Power Module, if required)
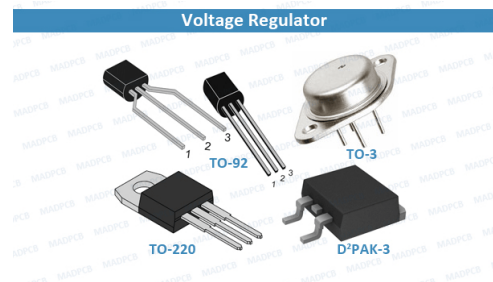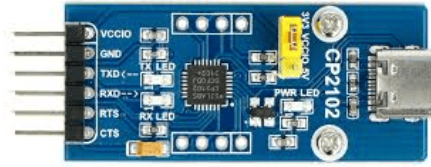

Figure 4: Voltage Regulator Module

This module maintains stable operating voltage for the ESP32, motors, and sensors, and prevents damage caused by over-voltage or sudden fluctuations.

4.6 USB-to-TTL Programmer (FTDI / CP2102)

Figure 5: USB-to-TTL Programmer

It is mainly used during the development phase to upload firmware to the ESP32-CAM and support serial debugging.

4.7 Jumper Wires and Connectors

These provide proper electrical connections between the ESP32, motor driver, battery, and sensors, while also offering flexibility and easy maintenance of wiring.

4.8 MicroSD Card (Optional)

It stores photos, videos, or sensor data directly from the ESP32-CAM, making it useful for data logging and offline review.

4.9 Mounting Hardware (Screws, Standoffs, Adhesive Tape, etc.)

This hardware securely holds all the components in place on the chassis, improving durability and keeping the build neat.

4.10 Optional Add-ons (LEDs / Buzzer)

LEDs and buzzers are used to provide status indications such as power ON, Wi-Fi connected, or sensor alerts, enhancing usability and feedback during operation.

4.11 Ultrasonic Sensor (HC-SR04)

Figure 6: Ultrasonic Sensor

The ultrasonic sensor detects obstacles to prevent collisions and enables safe navigation by triggering automatic turning or stopping.

4.12   Gas/Smoke Sensor (MQ-2 / MQ-135)

Figure 7: Gas/Smoke Sensor

This sensor monitors hazardous gases like LPG, smoke, or air pollution and triggers alerts for safety monitoring when detection occurs.

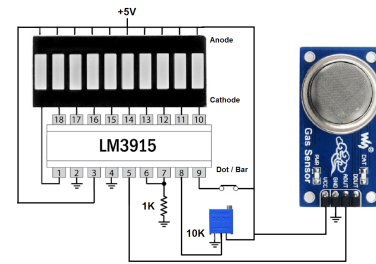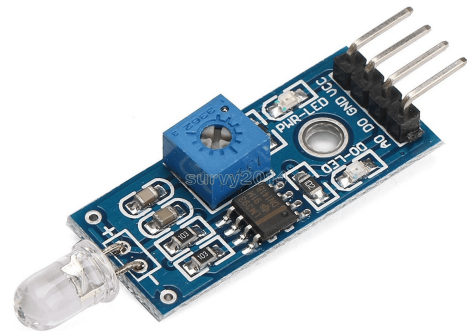## 4.13   Light Sensor (LDR / Photocell)

Figure 8: Light Sensor

It measures ambient light levels and can activate night-mode recording or raise alerts when sudden light changes are detected.

5   Features

1. Real-Time Video Streaming

2. Web-Based Control

3. Lightweight & Efficient Design

4. Battery Powered & Portable

5. Remote Surveillance with Sensors

5.1   Real-Time Video Streaming

The ESP32-CAM's built-in camera continuously streams live video, allowing users to view the rover's surroundings instantly. The video feed is accessible through any standard web browser, providing smooth, real-time monitoring.

5.2   Web-Based Control

The rover does not require any extra mobile apps or software. Instead, it is controlled via a simple HTML-based web interface hosted by the ESP32-CAM. Users can issue commands (forward, backward, left, right) directly from a laptop, tablet, or smartphone browser.

5.3   Lightweight & Efficient Design

To keep the system simple and cost-effective, the design avoids complex mechanisms like pan-tilt camera mounts. The rover focuses on efficient video streaming and smooth navigation, reducing both hardware complexity and power consumption.

5.4   Battery Powered & Portable

A rechargeable battery pack powers the entire system, enabling wireless mobility. This allows the rover to move freely without being tethered to external power, making it more practical for real-world use.

5.5   Remote Surveillance with Sensors

The rover can function as a mobile surveillance unit.

- Ultrasonic sensor avoids obstacles automatically.

- Gas/Smoke sensor detects hazardous gases.

- Light sensor monitors ambient light changes for alerts or mode adjustment.

6 Flowchart

Power ON

ESP32-CAM Initialization
- Wi-Fi Server
- Camera

Web Browser Connection
- Access UI

Web Interface Loaded
- Video Stream
- Control Buttons

Ultrasonic Sensor

User Input Command

Gas/Smoke Sensor

Light Sensor

Forward   Backward

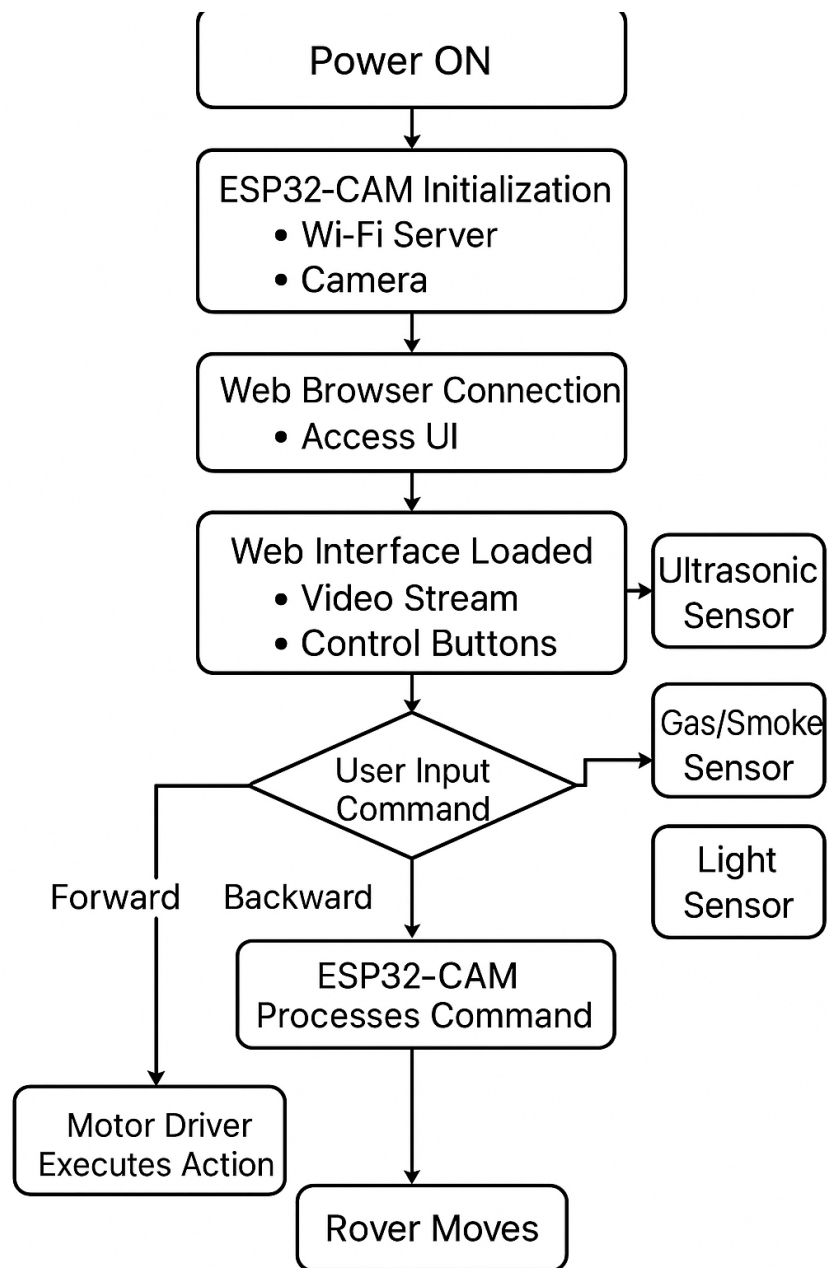ESP32-CAM Processes Command

Motor Driver Executes Action

Rover Moves

Figure 9: Flowchart of ESP32-CAM Surveillance Rover Operation