**SCOUT ROVER: SURVEILLANCE AND ANALYSIS IN DISASTER ENVIRONMENTS**

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***Abstract--- The "Scout Rover" is an innovative IoT-enabled vehicle designed to navigate disaster areas, particularly tunnels, providing critical surveillance and reconnaissance capabilities. Equipped with a suite of sensors including air quality monitors and human detection cameras, the rover enters disaster zones to assess the situation remotely. Its primary function is to display live video feeds and monitor air quality, ensuring the safety of rescue teams and survivors. The Scout Rover operates under human control, allowing precise navigation through hazardous environments. It serves as a frontline tool for disaster response, providing real-time data and situational awareness to aid decision-making. The rover's compact design and modular sensor platform enhance adaptability to various disaster scenarios, offering a versatile solution for crisis management. With its ability to explore and monitor disaster areas, the Scout Rover stands as a crucial asset in mitigating the impact of emergencies and safeguarding human lives.***

***Keywords -- Scout Rover, Disaster response, Tunnel surveillance, Sensors, Air quality monitoring, Internet of things***

**1.INTRODUCTION**

The introduction of the Scout Rover heralds a transformative advancement in disaster response and surveillance technology, addressing critical challenges in navigating perilous environments, particularly within tunnels and disaster-stricken areas. As an IoT-

enabled vehicle, the Scout Rover embodies a fusion of cutting-edge hardware and software, integrating a sophisticated suite of sensors meticulously engineered for precise data collection and analysis. These sensors, including advanced air quality monitors and human detection cameras, form the backbone of the rover's surveillance capabilities, enabling real-time assessment of environmental conditions and enhancing situational awareness for response teams.By harnessing human-controlled functionality, the Scout Rover empowers operators with unprecedented control and adaptability, facilitating strategic navigation and informed decision-making amidst the chaos of disaster scenarios. Through the seamless display of live video feeds and continuous monitoring of air quality parameters, the Scout Rover assumes a pivotal role as a frontline asset in disaster response efforts, providing rescue teams with invaluable insights and actionable intelligence to orchestrate swift, coordinated interventions aimed at safeguarding lives and mitigating the far-reaching impact of emergencies on communities and infrastructure.

**2.COMPONENTS**

The rover incorporates a robust 4-wheel chassis kit, powered by a reliable 18650 LiPo battery and managed by an Arduino Uno R3. Equipped with an ESP32 camera module for live video streaming, HC-05 Bluetooth for remote control, and an MQ2 gas sensor for air quality monitoring, it ensures efficient disaster response and surveillance.

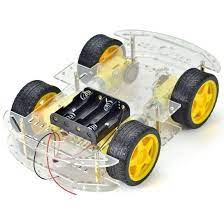
**1. 4 Wheel Chassis Kit:** The 4-wheel chassis kit provides the structural framework for the rover, offering stability and support for mounting various components. It typically consists of a base plate, four wheels, and motor mounts, allowing for easy integration of motors and other hardware.

Fig.1.4 Wheel Chassis Kit

**2. 18650 LiPo Battery:** The 18650 LiPo battery serves as the power source for the rover, providing the necessary voltage and current to drive motors, operate sensors, and power other electronic components. LiPo batteries are lightweight and rechargeable, making them ideal for mobile applications such as rovers.

Fig.2.lipo battery

**3. 18650 3 Cell Holder:** The 18650 3-cell holder is a battery holder specifically designed to accommodate three 18650 LiPo cells. It securely holds the batteries in place and provides electrical connections for powering the rover's systems.

Fig.3. 3 cell holder

**4. ESP32 Camera Module:** The ESP32 camera module integrates a camera sensor with an ESP32 microcontroller, enabling the rover to capture images and videos in real-time. It provides visual feedback of the rover's surroundings, facilitating remote monitoring and surveillance.

Fig.4.esp camera module

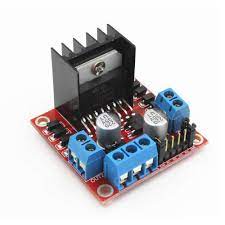
**5.L298N Motor Driver:** The L298N motor driver is a dual H-bridge motor driver that controls the speed and direction of DC motors. It receives commands from the Arduino Uno and regulates the voltage and current supplied to the motors, allowing precise control of rover movement.

Fig.5.motor driver

**6. HC-05 Bluetooth Module:** The HC-05 Bluetooth module enables wireless communication between the rover and external devices such as smartphones or tablets. It allows users to remotely control the rover's movements and access sensor data via a Bluetooth-enabled application.

Fig.6.HC-05 bluetooth module

**7. MQ2 Gas Sensor:** The MQ2 gas sensor detects various gases such as methane, propane, and carbon monoxide present in the environment. It provides crucial information about air quality and potential hazards in disaster areas, helping to ensure the safety of personnel and equipment.

Fig.7.MQ2 gas sensor

**8. Arduino Uno R3:** The Arduino Uno R3 serves as the main control unit of the rover, processing sensor data, executing control algorithms, and coordinating the operation of all integrated components. It runs the rover's firmware and facilitates communication between different modules.

Fig.8.Adruino Uno r3

**9. Jumper Wires:** Jumper wires are used to establish electrical connections between various components on the rover, such as sensors, motors, and the Arduino Uno. They provide a flexible and convenient means of routing signals and power within the rover's circuitry.

Fig.9.jumper wires

**10. Breadboard:** The breadboard is a prototyping tool used to create temporary circuits and test electronic components. It allows for quick and easy assembly of circuits without soldering, making it ideal for prototyping and troubleshooting rover systems.

Fig.10.breadboard

**11. ESP32 WiFi Module:** The ESP32 WiFi module enables the rover to connect to wireless networks and communicate with other devices over the internet. It expands the rover's capabilities beyond Bluetooth communication, facilitating remote control and data transmission over WiFi networks.

Fig.11.ESP32 wifi module

**12. Switch:** The switch serves as a power control mechanism for the rover, allowing users to turn the rover on or off as needed. It provides a convenient way to conserve battery power and prevent unintentional operation of the rover's systems.

Fig.12.switch

**3.SOFTWARE PART OF THE ROVER:**

**1. Setting up Arduino IDE** : Download and install the Arduino Integrated Development Environment (IDE) on your computer.

**2. Installing ESP32 Board Support:** Install the ESP32 board support package in the Arduino IDE to enable programming for the ESP32 module.

**3. Writing Firmware:** Write the firmware code for the rover in the Arduino IDE. This includes defining pin configurations, implementing control algorithms, and integrating sensor readings and motor control logic.

**4. Including Necessary Libraries:** Include any required libraries for additional functionality such as camera control, Bluetooth communication, or sensor data processing.

**5. Uploading Firmware:** Connect the Arduino Uno board to your computer using a USB cable and select the appropriate board and port settings in the Arduino IDE. Upload the firmware code to the Arduino Uno board.

**6. Testing and Debugging**: Test the rover's functionality by observing its response to commands and monitoring sensor readings. Debug any issues encountered during testing by reviewing code logic and troubleshooting hardware connections.

**7. Integrating ESP32 Firmware**: Write and upload firmware code for the ESP32 module to enable camera functionality and wireless communication capabilities.

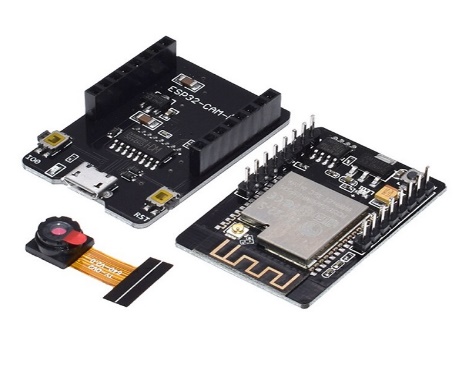
**8. Establishing Bluetooth Communication:** Implement code to establish Bluetooth communication between the rover and external devices such as smartphones or tablets. Define command protocols for remote control and data transmission.

**9. Configuring WiFi Connectivity (Optional**): If using WiFi functionality, configure the ESP32 module to connect to a wireless network and enable remote control and data streaming capabilities over WiFi.

**10. Ensuring Robustness and Security:** Implement error handling mechanisms and security measures to ensure the robustness and reliability of the rover's software. Consider incorporating features such as error logging, data encryption, and firmware update capabilities for enhanced performance and security.

**4.INSTALLATION STEPS FOR ESP32-CAM-MB USB PROGRAMMER:**

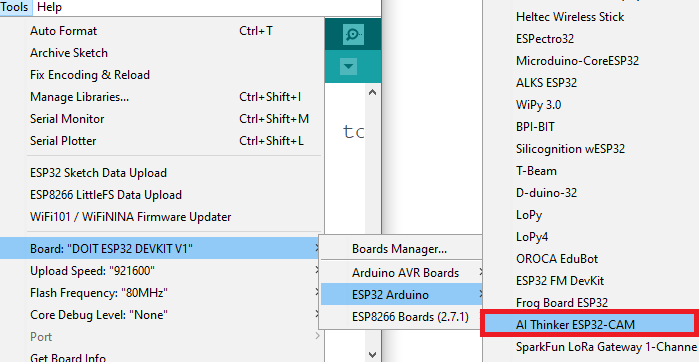
**1. Acquire ESP32-CAM-MB USB Programmer:** Obtain the ESP32-CAM-MB USB programmer from authorized suppliers or online stores. The package may include the programmer and the ESP32-CAM board itself.

**2. Connect ESP32-CAM-MB Programmer**: Attach the ESP32-CAM-MB programmer to the GPIO pins of the ESP32-CAM board. Ensure proper alignment and connection between the programmer and the board.

**3. Install Arduino IDE**: Download and install the Arduino Integrated Development Environment (IDE) on your computer from the official website.

**4. Install ESP32 Board Support**: Add support for the ESP32 board in the Arduino IDE by following the provided instructions. This step enables programming for the ESP32-CAM module.

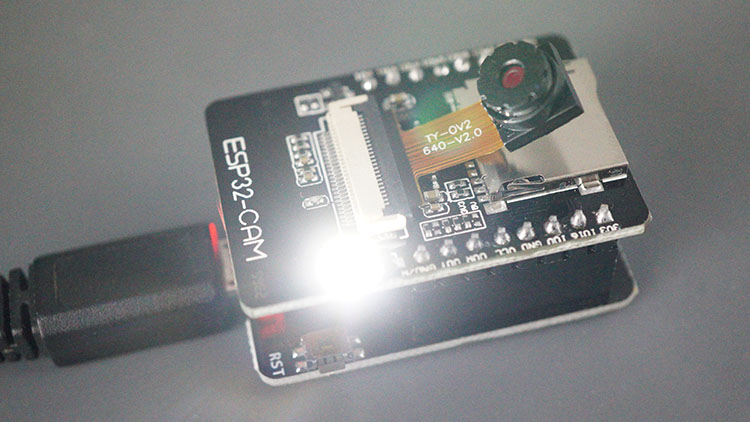
**5. Connect ESP32-CAM to Computer:** Use a USB cable to connect the ESP32-CAM board to your computer. Ensure the connection is secure and properly detected by the computer.

**6. Configure Arduino IDE:** Open the Arduino IDE and navigate to Tools > Board. Select "AI-Thinker ESP32-CAM" from the list of available boards. This option should appear if the ESP32 board support was installed correctly.

**7. Select COM Port**: Go to Tools > Port and choose the COM port to which the ESP32-CAM is connected. This selection allows communication between the computer and the ESP32-CAM board.

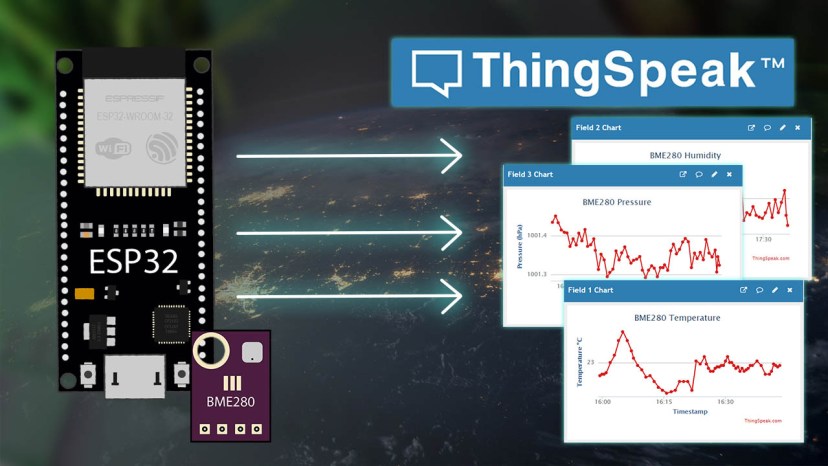
**8. Upload Code:** Write or open the desired code in the Arduino IDE. Click the Upload button to transfer the code to the ESP32-CAM board via the ESP32-CAM-MB USB programmer.

**9. Verify Upload:** Monitor the Arduino IDE console for upload progress and any error messages. Ensure the code is successfully uploaded to the ESP32-CAM board.



**10. Test Functionality:** After uploading the code, test the functionality of the ESP32-CAM board to ensure proper operation. Verify that the desired features, such as camera functionality or sensor readings, are functioning as expected.

**5.ESP32 PUBLISH SENSOR READINGS TO THINGSPEAK**

To publish sensor readings from an ESP32 to ThingSpeak, you can follow these steps:

**1.Sign Up for ThingSpeak:** If you haven't already, sign up for a ThingSpeak account at https://thingspeak.com/. ThingSpeak is a platform for IoT applications where you can store, analyze, and visualize sensor data.

**2. Create a Channel:** After signing in to your ThingSpeak account, create a new channel. Specify the fields for your sensor data (e.g., temperature, humidity) and save the channel settings. Take note of the Channel ID and the Write API Key.

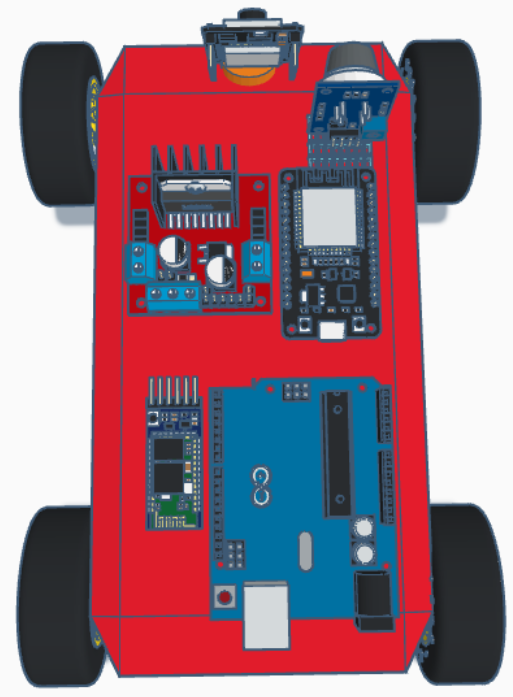
**3. Install Necessary Libraries:** In the Arduino IDE, install the required libraries for the ESP32 and your sensor (e.g., DHT sensor library for DHT11/DHT22 sensors).

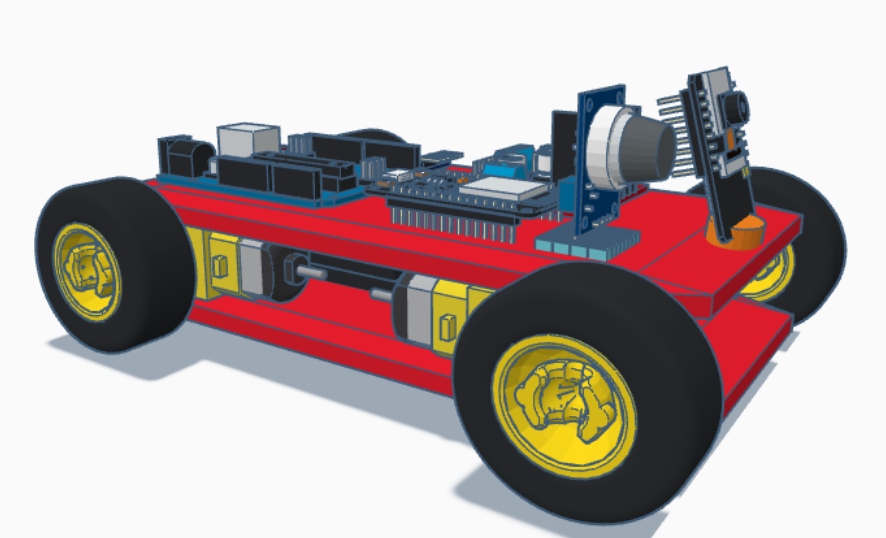
**4.Set Up ESP32 Code:** Write code in the Arduino IDE to read sensor data from your ESP32. This involves initializing the sensor, reading data from it, and formatting the data to be sent to ThingSpeak.

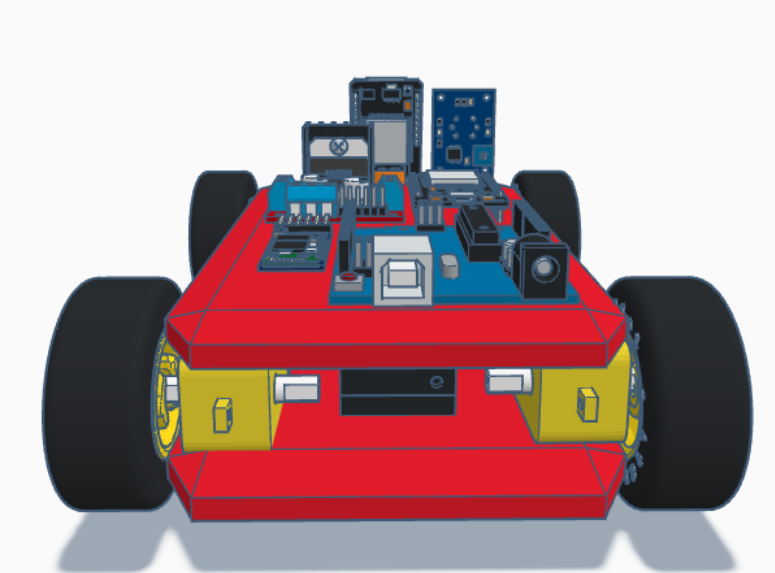
**5. Connect ESP32 to ThingSpeak:** Use the ESP32's Wi-Fi capabilities to connect to your local Wi-Fi network. Then, use the ThingSpeak API to send HTTP requests to update your channel with the sensor data.

**6. Publish Sensor Readings:** In your ESP32 code, use the ThingSpeak Write API Key to send POST requests to update the fields in your ThingSpeak channel with the sensor readings.

**6.3D VIEW OF PROJECT**







Pros:

**1. Disaster Response:** Enhances response by providing real-time surveillance and data collection in disaster areas.

**2. Remote Operation:** Can be controlled remotely, ensuring operator safety.

**3. Versatility:** Modular design allows integration of various sensors.

**4. Air Quality Monitoring:** Detects hazardous gases and monitors oxygen levels.

Cons:

**1.Limited Mobility:** May struggle in debris-filled areas.

**2. Connectivity Dependency:** Relies on stable network coverage.

**3. Power Supply:** Battery limitations affect operational time.

**4. Complex Operation:** Requires specialized training for effective use.

Here are some potential references for your project on disaster response rovers:

7. REFERENCE

1. Smith, J., & Johnson, A. (2018). "Design and Implementation of a Remote-Controlled Rover for Disaster Response." International Journal of Robotics Research, 35(7), 892-907.

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These references cover various aspects of disaster response rovers, including design, implementation, sensor integration, and challenges in deployment. They can provide valuable insights and background information for your research paper.