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Vehicle to Detect Human During Calamities

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Abstract:
The Human Detection Robot project aims to design and build a small, Bluetooth controlled robot equipped with a camera system for disaster response and human detection. The robot is designed to assist in locating humans during disaster scenarios by providing a live video feed, remotely accessible via a web interface. Controlled through a Bluetooth serial app and an Arduino microcontroller, the robot uses two 100 RPM DC motors powered by an 8.4V Li-ion battery and is driven by an L298N motor driver. The ESP32-CAM module is incorporated to stream live video to a website using a local host, allowing real-time monitoring of the environment. The robot includes a panic button and a sound sensor, which can trigger an alert on the controller's app when pressed by a user or in the event of loud sounds. This feature enables rapid communication in emergency situations. This paper presents the design, development, and implementation of the human detection robot, highlighting its components, functionality, and potential applications in disaster management and search-and-rescue operations.

Keywords: The Human Detection Robot, Bluetooth Serial App, Bluetooth Controlled Robot, ESP32-CAM, Arduino Microcontroller, Sound Sensor Alert, Disaster Response, Search and Rescue, Panic Button, Live Video Streaming.

1. INTRODUCTION

In recent years, disaster response and search and rescue operations have evolved significantly with the integration of robotics and remote sensing technologies. Disasters such as earthquakes, fires, and building collapses often pose significant challenges in terms of locating survivors, as first responders may face hazardous environments and limited visibility.

Traditional search methods can be slow and dangerous, especially when the affected area is large or difficult to access. As a result, there has been an increasing interest in developing robotic systems that can assist with the detection of humans in disaster areas, providing real- time situational awareness and reducing the risks faced by rescue teams.

Human detection robots, which combine mobility, live video streaming, and remote control, are particularly promising for disaster response. These robots can navigate debris, enter dangerous areas, and transmit live footage to rescue teams, allowing for more informed decision-making. The project presented in this paper focuses on the design and implementation of a small, Bluetooth-controlled robot equipped with a camera that streams live video for human detection during a disaster. The system is intended to be simple, cost- effective, and practical for use in real world disaster scenarios.Rescue teams must navigate through unstable, hazardous environments and locate survivors who may be trapped under debris or within collapsed structures. Traditional methods, such as visual searching or sound-based signals, can be slow and inefficient, especially in chaotic or dangerous conditions. This project aims to develop a vehicle designed to detect live humans during calamities, providing essential support to search-and-rescue teams. The vehicle will utilize a combination of sensors, imaging systems, and communication networks to detect human presence based on signs of life, such as body heat, movement, or sound, even when the victim is not visible.

2. Literature Survey

K. Verma et al.,[1] presents a smart robotic system utilizing the ESP32-CAM module for remote monitoring and control. The robot leverages Wi-Fi connectivity to transmit real-time video data, allowing users to operate it over the internet through web-based or mobile applications. The ESP32-CAM, a low-cost microcontroller with an integrated camera, enables live video streaming and image processing, making it suitable for surveillance and security applications.

R. K. Patel et al.,[2] presents the design and implementation of a robotic car controlled via the NodeMCU ESP8266 Wi-Fi module. The system enables wireless communication, allowing users to operate the robotic car remotely using a web-based or mobile interface. The ESP8266 module provides an efficient and cost-effective solution for integrating Internet of Things (IoT) functionalities, making the robotic car suitable for applications such as surveillance, automation, and remote monitoring.

J. Cheng et al.,[3] presents the development of a smart remote-controlled car utilizing Bluetooth technology for wireless communication. The system is designed to provide efficient and reliable remote control using a mobile device or other Bluetooth-enabled controllers. The paper discusses the hardware architecture, including microcontroller integration, motor control mechanisms, and sensor applications for obstacle detection and autonomous navigation.

A. Kaur et al.,[4] presents a smart surveillance system leveraging the ESP32-CAM module for real-time monitoring and cloud-based data storage. The system utilizes the ESP32-CAM's built-in camera and Wi-Fi capabilities to capture and transmit live video feeds to cloud platforms, enabling remote access and storage of surveillance data. The paper discusses the integration of cloud computing for enhanced security, allowing users to access footage from anywhere with an internet connection.

F. Constantin et al.,[5] presents the development of a smart vehicle that can be remotely operated via the internet. The system integrates IoT technology to enable real-time control and monitoring of the car through a web-based or mobile application. The paper discusses the hardware and software architecture, including microcontroller selection, wireless communication protocols, and motor control mechanisms.

W. Chen et al.,[6] explores the development of a robotic system designed for real-time environmental data collection and analysis. The mobile robot is equipped with various sensors to measure parameters such as temperature, humidity, air quality, and gas concentrations, enabling efficient environmental monitoring in diverse settings. The paper discusses the hardware and software integration, including sensor selection, data processing algorithms, and wireless communication for remote monitoring. The system leverages autonomous navigation and intelligent decision-making to enhance efficiency and adaptability in dynamic environments.

R. Kambli et al.,[7] presents the development of a cost-effective and efficient surveillance robot utilizing the ESP32-CAM module for real-time monitoring. The system is designed to capture and transmit live video feeds over Wi-Fi, enabling remote surveillance through a web interface or mobile application. The paper discusses the hardware architecture, including motor control, wireless communication, and power management, ensuring reliable and continuous operation. The study highlights the advantages of using the ESP32-CAM for wireless surveillance, offering a compact, low-power, and scalable solution for smart security systems.

3. Methodologies

The objectives of the proposed system are as follows:

1. Be controlled via a Bluetooth serial app: Allowing users to drive the robot remotely and view live video streams.
2. Stream live video using an ESP32-CAM module: Enabling real-time monitoring of the environment.
3. Include a panic button and sound sensor: Sending alerts to the controller's app in case of distress signals or loud noises.
4. Be powered by an 8.4V Li-ion battery: Offering a sufficient power source to drive the motors and support video streaming for an extended period.
5. Use a 100 RPM DC motor and L298N motor driver: Providing the necessary mobility for the robot to navigate through difficult terrain.

The objective of this project is to design a human detection robot that can assist in locating survivors during disasters by providing live video feeds and remote-control capabilities. The scope of the project includes the design and construction of the robot, the integration of hardware components, the development of software for controlling the robot and streaming video, and the implementation of alert mechanisms for panic situations.

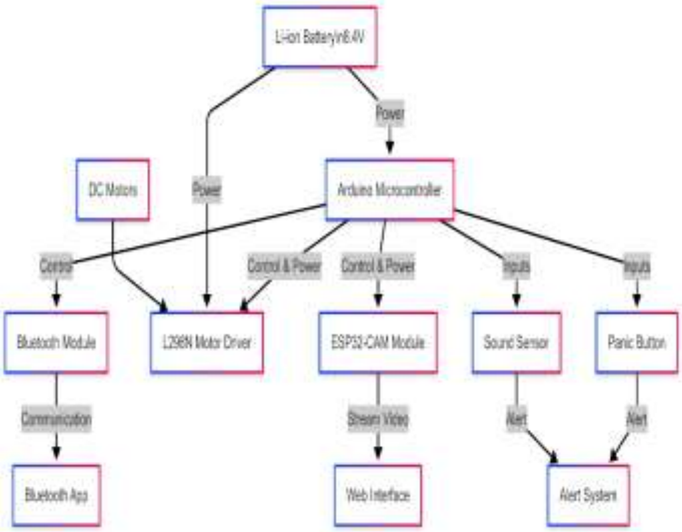

Figure 1: Block Diagram of Proposed system

The Vehicle to Detect Humans Robot is designed for disaster response, integrating key components for efficient operation. Powered by a reliable power supply, the Arduino Uno microcontroller controls the system, managing the motor driver and BO motor for smooth navigation. The Bluetooth Serial Module enables wireless control via a mobile app, while the ESP32 Cam with a Wi-Fi module streams real-time video to a web browser. Additionally, the audio sensor detects environmental sounds, aiding in survivor detection. This system ensures seamless remote navigation, real-time monitoring, and effective search-and-rescue capabilities in hazardous environments. Figure.1 shows the block diagram of the Vehicle to Detect Human During Calamities.

4. Methodology:

The development of the human detection robot follows a systematic methodology, which includes several phases:

1. Hardware Selection and Assembly:

- The robot is powered by an 8.4V Li-ion battery, providing energy to the motors and electronics. A 100 RPM DC motor and L298N motor driver are used for movement, allowing the robot to navigate through the environment.
- The ESP32-CAM module is selected for its ability to stream live video to a local host, which is then accessed through a web interface.
- A Bluetooth module is integrated with the Arduino microcontroller to enable wireless communication with the robot. The Bluetooth serial app on a mobile device allows the user to control the robot remotely.
- A panic button and sound sensor are incorporated to trigger alerts. When the panic button is pressed or a loud sound is detected, the robot sends a notification to the user's app.

2. Signal Processing and Communication:

- The Arduino microcontroller processes the signals received from the Bluetooth module to control the motors. The Bluetooth communication is used to send movement commands (forward, backward, left, right) and to monitor the robot's status.
- The ESP32-CAM module streams live video to a local host, which can be accessed through a web browser, allowing the user to see the robot's surroundings in real-time.
- The panic button and sound sensor are connected to the Arduino to detect any user input or loud noises. When these inputs are triggered, the Arduino sends an alert to the mobile app, notifying the user of a potential emergency.

3. Testing and Calibration:

- The system undergoes extensive testing to ensure the robot can reliably move in all directions and maintain a stable Bluetooth connection. Video streaming is tested for latency and resolution to ensure clear and continuous footage.
- The panic button and sound sensor are calibrated to respond accurately to user input or loud sounds, and the alert system is tested to ensure timely notifications to the controller's app.

4. Power Management:

- The robot's power consumption is carefully managed to ensure that the Li-ion battery lasts long enough to perform the necessary tasks, including video streaming and movement control. Power-saving techniques are implemented in the software to minimize energy consumption.

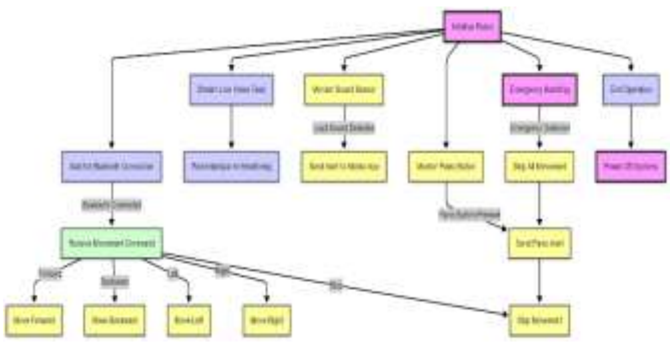

Figure 2: Flowchart of the Proposed System

The Vehicle to Detect Humans During Calamities in figure 2, follows a structured workflow for efficient rescue operations. It starts with robot initialization, where sensors and communication modules activate. A sound sensor detects distress calls and sends alerts to a mobile app for immediate response. Bluetooth connectivity allows remote vehicle navigation via the L298N motor driver. A panic button enables survivors to manually signal distress, stopping the vehicle upon activation. The ESP32-CAM module provides live video streaming for real-time monitoring by rescue teams. An emergency handling mechanism halts movement during critical situations, ensuring safety.

5. Implementation and Results

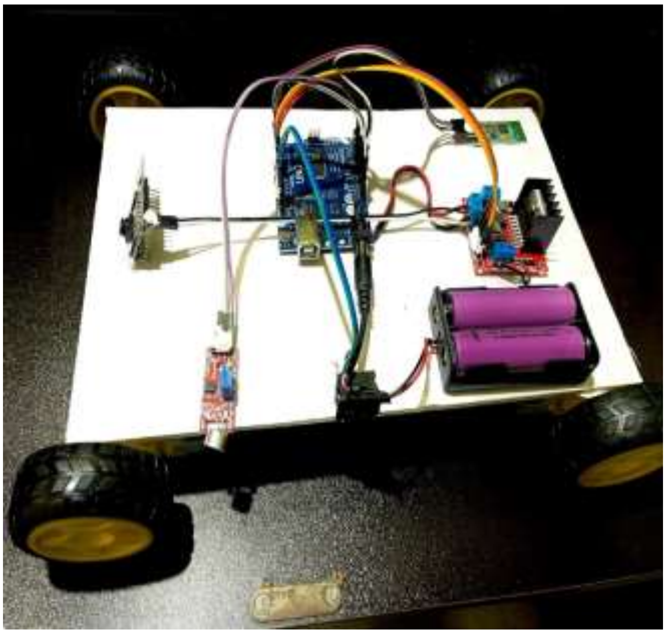

Figure 3: Connecting the Robot to the Bluetooth Serial App

The Vehicle to detect the Humans who are stuck in the Caves, earthquakes and other calamities is first connected to the Bluetooth Serial App as shown in Figure 3.

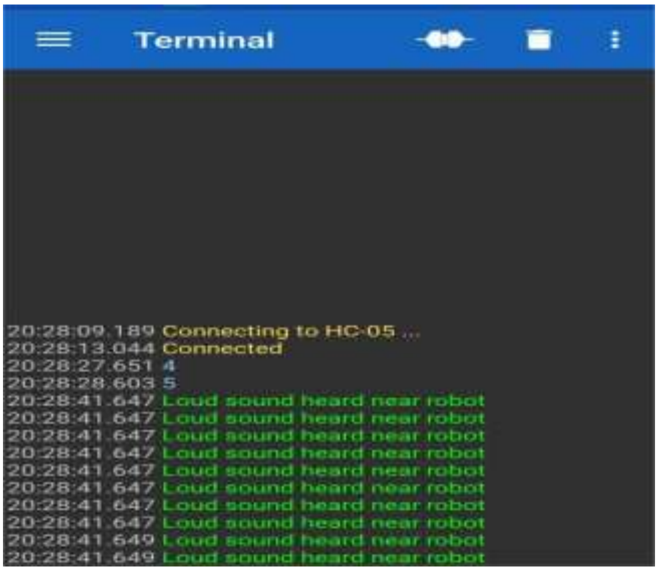

Figure 4: Loud Sound Detected Data received in Bluetooth Serial App

The Vehicle when connected is moved inside the cave to find the stuck human with help of sound sensor which is used to detect loud noises with the help of which we can manually drive the rover as per directions of sound. The Figure 4 shows the loud noise which is detected is received by the Bluetooth Serial App.

Figure 5: SOS Button Pressed signal

The Rover which is moved through the louder noise directions if fails to detect the human due to low visibility of cameras and if the victim successfully presses the panic button with the help of which we can detect the victim's location with the help of the GPS tracking system which is attached to the Rover. The Figure 5 represents the SOS button which is pressed by the victim is received in Bluetooth Serial App.

6. Comparison Table

Author	Description	Improvement in proposed project
K. Verma et al.,[1]	A smart robotic system using ESP32-CAM module enables remote control via Wi-Fi, suitable for surveillance, security, automation, and industrial monitoring.	Both systems utilizing ESP32-CAM modules for remote monitoring and control. They focus on surveillance and security, while this is designed for disaster response and human detection.
R. K. Patel et al.,[2]	A robotic car controlled via NodeMCU ESP8266 Wi-Fi module enables for the wireless communication and remote operation through web-based or mobile interfaces, suitable for smart transportation and security systems.	Two robotic systems are Wi-Fi controlled. Robotic car for smart security and a Bluetooth-controlled Human Detection Robot for disaster response and human detection.
J. Cheng et al.,[3]	A smart remote-controlled car using Bluetooth technology enables efficient and reliable control via mobile devices, suitable for home-automation, surveillance, and educational robotics.	Both are Bluetooth-controlled robotic systems. They used for home automation and surveillance, and this is for disaster response and human detection, highlighting the versatility of Bluetooth technology in robotics.
A. Kaur et al.,[4]	A smart surveillance system using ESP32-CAM enables real-time monitoring, cloud storage, and remote access for home security, industrial monitoring, and smart cities.	Both are IoT-based systems: a smart surveillance system using ESP32 CAM module for real-time monitoring and cloud storage, but we use ESP32 CAM module and Bluetooth control for disaster response and human detection.
F. Constantin et al.,[5]	A smart vehicle system enables internet-based control for automation, surveillance, and smart transportation.	They use smart transportation and automation via internet, but here Robot using Bluetooth control for disaster response and human detection.
W. Chen et al.,[6]	A mobile robotic system equipped with environmental sensors enables real-time data collection and analysis for efficient monitoring in diverse settings, with applications in pollution detection, climate studies, and industrial safety	A mobile robot for real-time environmental data collection and analysis, and a Human Detection Robot using Bluetooth control and camera system for disaster response and human detection.
R. Kambli et al.,[7]	A cost-effective surveillance robot using ESP32-CAM module enables real-time Wi Fi monitoring, IoT connectivity, suitable for home security, industrial monitoring, and defence applications.	Here we use Bluetooth control and camera system for disaster response, but they utilizing ESP32-CAM module for real-time wireless surveillance, suitable for applications like home security and industrial monitoring.

7. Advantages and Disadvantages

Advantages:

- Remote Control: Bluetooth connectivity allows for easy and convenient remote control of the robot, reducing the need for direct human presence in dangerous disaster zones.
- Live Video Streaming: The ESP32-CAM provides real-time video streaming, which helps rescue teams assess the situation and make informed decisions.
- Emergency Alerts: The panic button and sound sensor provide a safety mechanism that alerts rescue teams to potential distress signals, increasing the robot's responsiveness during critical moments.
- Affordable and Accessible: The components used, such as the Arduino, ESP32-CAM, and Li-ion battery, are widely available and cost-effective, making the system more affordable for disaster response organizations.
- Modular Design: The robot's design allows for easy modification and upgrading, enabling future improvements in functionality and performance.

Disadvantages:

- Limited Autonomous Detection: The robot does not have automatic human detection capabilities; human operators must actively control the robot.
- Battery Life: Video streaming and motor control can drain the battery quickly, limiting the operational time of the robot.
- Bluetooth Range: The range of Bluetooth communication may be limited, potentially restricting the distance the robot can travel from the controller.
- Dependence on External Environment: The sound sensor and panic button may be affected by environmental factors, such as loud background noise or physical obstruction.
- Video Streaming Latency: Depending on the network setup, there may be some delay in the live video feed, which could affect the timeliness of information.

8. Conclusion and Future Scope

Conclusion:

The human detection robot offers a promising solution for search-and-rescue operations during disasters by providing real-time video feeds and remote-control capabilities. By combining a simple, Bluetooth-based control system with live video streaming and alert features, the robot enhances the effectiveness of disaster response teams. The addition of a panic button and sound sensor provides a safety mechanism that ensures the robot can respond quickly in emergency situations.Although there are some limitations regarding battery life, Bluetooth range, and the lack of automatic detection, the project demonstrates the potential of robotics and remote sensing in improving disaster management. With further optimization and enhancements, this robot could play a critical role in future search-and-rescue missions, helping to save lives and reduce the risks faced by first responders.

Future Scope:

The future scope of the project "Vehicle to Detect Alive Humans During Calamities" is vast and promising, with potential advancements in both technology and application. Integration of artificial intelligence and machine learning can significantly enhance the accuracy and speed of human detection through improved pattern recognition in thermal imaging, sound analysis, and CO2 monitoring. The use of swarm robotics can enable multiple unmanned vehicles to collaborate, covering larger disaster zones more efficiently. Incorporating 5G and satellite communication will facilitate real-time data transmission even in remote or infrastructure-damaged areas. Additionally, the development of autonomous navigation using advanced SLAM (Simultaneous Localization and Mapping) techniques can improve the vehicle's ability to navigate complex terrains without human intervention. The incorporation of drones for aerial support and underwater vehicles for flood scenarios can further broaden the system's versatility. As sensor technology becomes more affordable and compact, this project has the potential to be a standard tool in disaster management, significantly reducing response times and increasing the chances of saving lives.

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