Rescue Rover: a Sound-Activated Arduino-Based Emergency Response Vehicle with Ultrasonic Obstacle Avoidance

Md. Bakibillah Rahat, Richard Victor Biswas and Nafisa Maliyat

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Abstract—**In this project, we propose an Arduino-based rescue car designed to detect sound and navigate toward its source autonomously. The rescue car is equipped with an ultrasonic sensor and a servo motor for obstacle detection and avoidance, ensuring its ability to navigate complex environments. Upon reaching the sound's source, the car emits a beep to signal its arrival. Additionally, the car is integrated with a BMP180 sensor for temperature detection, with the data displayed on a 1.3-inch I2C OLED display. The temperature data is also transmitted to a user's phone via a Bluetooth module, enabling remote monitoring of the rescue car's environment.**

***Index Terms*—Arduino, Rescue vehicle, Sound detection, Ultrasonic sensor, Temperature monitoring, Bluetooth module.**

I. INTRODUCTION

Natural catastrophes and emergencies are unexpected and can strike at any time, inflicting harm to both humans and animals. During such catastrophes, first responders play a key role in preserving lives and limiting damage. Nevertheless, getting to the impacted areas might be difficult due to different barriers such as blocked roads and falling debris. In such cases, an autonomous rescue vehicle can be of great assistance because it can quickly navigate through obstacles and reach the affected areas to provide assistance.

The goal of this project is to design and build an Arduino-based rescue vehicle that can detect and respond to sound in emergency scenarios. To identify barriers in its route, the automobile will be outfitted with an ultrasonic sensor and a servo motor. If an obstruction is spotted, the automobile will take a different path to its destination. As the automobile arrives at the source of the sound, it will produce a beep sound to signify its arrival. The automobile will also contain a BMP180 sensor for temperature detection, with the data displayed on a 1.3- inch I2C OLED display. Furthermore, the BMP180 sensor data will be sent to a phone through a Bluetooth module.

The report will begin with an introduction that provides the background of the study and the project objectives. This will be followed by a literature review, where we will discuss related projects published in the last four years (2018-2022). Next, we will describe the methodology and modelling of our project, including the working principle of the proposed rescue car and the components used in the project. We will then present the results and discussion of our experiments, including the car's obstacle avoidance and sound detection capabilities. Finally, we will provide our conclusions and future endeavors, along with the references used in the report.

II. LITERATURE REVIEW

To develop our project, we conducted a literature review of related projects and methodologies published in the last five years (2018-2022). The literature review helped us to identify best practices and design considerations for each area of research."A Survey of Mobile Robots for Search and Rescue Operations" by A. M. A. Al-Saggaf et al. (2018)[2]. This study presents a detailed assessment of mobile robots used in search and rescue missions. The writers discuss the many types of mobile robots and their uses, as well as the obstacles and constraints involved with their employment. The study also addresses the most recent advancements in mobile robot technology, such as sensors, navigation systems, and communication technologies."An Autonomous Robotic System for Search and Rescue Missions" by M. T. Al-Ratrout et al. (2020)[3]. The design and deployment of an autonomous robotic system for search and rescue operations is presented in this study. The system comprises of a mobile robot outfitted with numerous sensors and cameras, as well as a control system that allows the robot to navigate complicated situations independently. The report also covers the difficulties and constraints of using autonomous robotic systems for search and rescue missions."Development of an Autonomous Mobile Robot for Rescue Missions" by M. G. Karkar et al. (2019)[4]. The concept and development of an autonomous mobile robot for rescue operations is described in this study. The robot is outfitted with a variety of sensors and cameras, as well as a navigation system that allows it to navigate complicated areas autonomously. The report also goes over the robot's communication technology, which allows it to provide realtime data to the rescue crew."A Review of Robotics in Search and Rescue Operations" by M. R. Islam et al. (2022) [5]. This study gives an up-to-date assessment of robots' application in search and rescue missions. The authors describe the many types of robots employed in these activities, as well as the most recent advances in robotics technology such as sensors, communication systems, and navigation systems. In addition, the study covers the problems and limits of using robotics in search and rescue operations, as well as future research objectives."Design and Development of an Autonomous Mobile Robot for Emergency Response Applications" by J.S. Saini et al. (2021) [6]. This study presents the design and development of an autonomous mobile robot equipped with various sensors and communication systems for emergency response applications. The robot's navigation and obstacle avoidance system, as well as its remote control capabilities, are discussed in detail."Intelligent Disaster Response Robot for Search and Rescue Missions" by

M. A. R. Al- Mamun et al. (2018) [7]. This study describes the design and development of an intelligent disaster response robot that is equipped with various sensors and communication systems. The robot's autonomous navigation and obstacle avoidance capabilities, as well as its ability to detect and locate victims in a disaster area, are discussed in detail."Development of a Robot for Disaster Response and Search and Rescue Operations" by S. S. Jaiswal et al. (2019) [8]. This paper presents the development of a robot for disaster response and search and rescue operations. The robot is equipped with various sensors, a communication system, and an advanced navigation system that allows it to navigate through challenging environments. The paper also discusses the challenges and limitations of using robots for disaster response and search and rescue operations.

III. METHODOLOGY AND MODELLING

A. Introduction

The proposed project is to build an Arduino-powered rescue vehicle that can detect sound and navigate toward it while avoiding obstacles. This section will discuss the methodology and modelling of the project, including the working principle, components, and testing process.

B. Working Principle of the Proposed Project

The rescue vehicle will identify and navigate around obstacles using an ultrasonic sensor and a servo motor. When a sound sensor detects it, the vehicle will travel toward it. When it arrives at the source of the sound, it will emit a beep to indicate its arrival. The temperature will be monitored by the BMP280 sensor and presented on a 1.3-inch OLED display. The BMP180 sensor data will be sent to a mobile device through the Bluetooth module.

C. Process of work

The Rescue Rover project involved several stages, including design and prototyping, component selection and assembly, programming and testing, and field testing.

1) **Design:** The project team will design the emergency response vehicle in this stage, including its size, form, and parts. This will entail modelling the vehicle in 3D using computer-aided design (CAD) software.
2) **Component selection:** The team will choose the parts required for the vehicle, including the Bluetooth module, servo motor, ultrasonic sensor, and sound detection module. Additionally, they will choose the proper batteries, wheels, and rear.
3) **Assembly:** The car will be built from individual parts. The group will assemble everything using soldering, wiring, and mechanical capabilities.
4) **Programming:** The motions and sensors of the vehicle will be managed by the Arduino microcontroller. In order to do this, a programming language like C++ will be used, and the microcontroller will receive the code.
5) **Testing:** The car will be put through its paces to make sure everything works as it should. Testing of the sound detection module and ultrasonic sensor will be required.
6) **Optimisation :** To enhance the performance of the vehicle, the crew will make any necessary modifications. Enhance the vehicle's responsiveness to various conditions, this can entail moving sensors around or modifying the algorithm.
7) **Final testing:** The vehicle will undergo final testing to ensure that it meets the project objectives and performs well under different emergency scenarios.
8) **Deployment:** The vehicle will be made available for use by emergency responders in real-world circumstances.

D. Description of the Components

The ultrasonic sensor will identify obstructions in the way, and the Arduino board will act as the vehicle's main computing unit. The vehicle will be able to avoid obstacles with the aid of the servo motor. The temperature will be monitored by the BMP180 sensor, while sound will be detected by the sound sensor. The OLED display will display the temperature data, and the Bluetooth module will transfer the BMP180 sensor data to a mobile device.

E. Experimental Setup

Setting up the Arduino: Connect your Arduino Uno to your computer using a USB cable. Connecting the sound sensors: Connect the first sound sensor to the Arduino's digital pins. For example, connect the VCC pin to 5V, GND to GND, and the OUT pin to digital pin 2. Similarly, connect the second sound sensor to the Arduino, using digital pin 3 for the OUT pin. Connecting the ultrasonic sensor (HC-SR04): Connect the VCC pin to 5V, GND to GND, the Trig pin to digital pin 4, and the Echo pin to digital pin 5. Connecting the BMP180 barometric pressure sensor: Connect the VCC pin to 3.3V, GND to GND, SDA to the Arduino's A4 pin, and SCL to the A5 pin.For an OLED display, connect the VCC pin to 3.3V or 5V, GND to GND, SDA to A4, and SCL to A5. Connecting the HC-05 Bluetooth module: Connect the VCC pin to 5V, GND to GND, TX to digital pin 0 (RX on the Arduino), and RX to digital pin 1 (TX on the Arduino) through a voltage divider (e.g., a 1k and 2k resistor) to reduce the voltage from 5V to 3.3V for the RX pin. Programming the Arduino: Install the necessary libraries for the BMP180 sensor and the display. Write code to take input from the sound sensors, control the car's movement, detect obstacles using the ultrasonic sensor, and measure weather data using the BMP180 sensor. Display weather information on the connected display and send it to the connected smartphone via the Bluetooth module. Assembling the car: Mount the Arduino, sensors, and display on the car chassis. Connect the motors to the Arduino using an appropriate motor driver. Testing the car: Power the Arduino and the car's motors. Test the sound-following functionality by making sounds near the sensors and observing the car's movement. Test the obstacle detection by placing objects in front of the ultrasonic sensor and ensuring the car stops or changes direction. Test the weather data collection and display on both the car's display and the connected smartphone. Connecting the motor driver: Assuming you are using an L298N motor driver, connect the following pins: ENA to Arduino digital pin 6 IN1 to Arduino digital pin 7 IN2 to Arduino digital pin 8 ENB to Arduino digital pin 11 IN3 to Arduino digital pin 12 IN4 to Arduino digital pin 13 Connect the motor driver's power supply pins to the appropriate voltage source (e.g., a battery) for the motors. Make sure to connect the GND of the power supply to the GND of the Arduino as well. Connect the motors to the motor driver's output pins (Motor A and Motor B).

F. Flowchart

The proposed flowchart outlines the operations of an autonomous, Arduino-based rescue car, designed to detect sound and navigate towards it. The process starts with the car activating its sound detection system, which prompts the vehicle to move towards the source. As the car navigates, its ultrasonic sensor and servo motor work in tandem to detect and avoid obstacles, ensuring smooth navigation even in complex terrains. Once the car reaches the sound's source, it acknowledges its arrival by emitting a beep. Concurrently, the BMP180 sensor on the car monitors the surrounding temperature. This data is then displayed on a 1.3-inch I2C OLED display on the car itself. For remote monitoring, the temperature data is also transmitted to a user's smartphone via a Bluetooth module. The flowchart highlights the car's self-navigation, obstacle avoidance, source location, and temperature monitoring abilities, outlining a comprehensive process for an innovative, Arduino-based rescue operation.

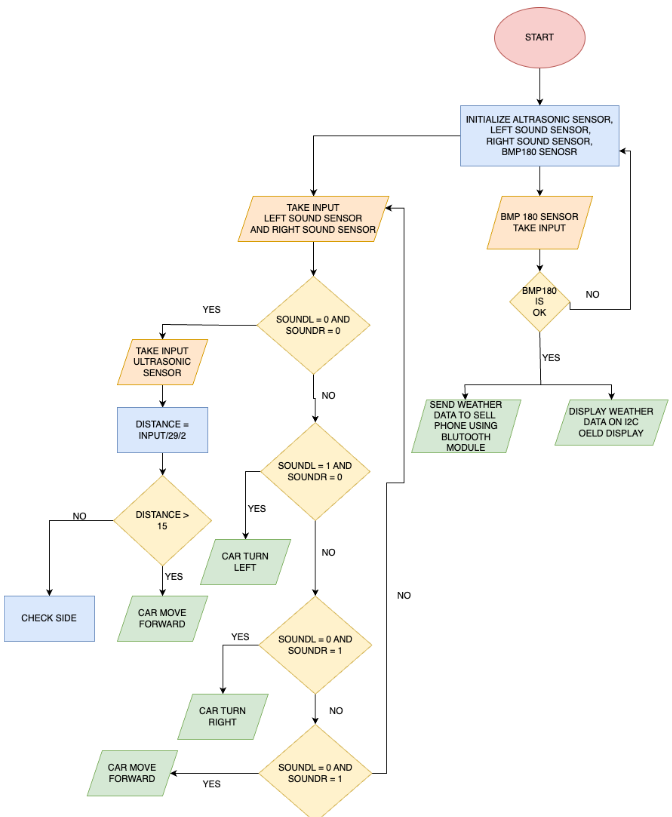

Fig. 1. Rescue Rover Flowchart.

G. SOCIETAL IMPACT

The "Rescue Rover" concept has the potential to significantly improve emergency response skills and perhaps save lives. Every second counts in an emergency, and using a tiny and lightweight vehicle that can travel through tight places and barriers may substantially cut reaction times and boost the odds of saving individuals in need. The employment of sound detection and ultrasonic obstacle avoidance technology by the vehicle improves its capabilities, allowing it to travel through complicated areas and avoid possible impediments. Furthermore, the use of a Bluetooth connection module allows for remote control and data transmission, increasing the vehicle's adaptability and accessibility for emergency responders. The "Rescue Rover" initiative has the potential to save lives by providing emergency responders with dependable and effective equipment.

IV. RESULT AND DISCUSSION

A. Simulation

This Arduino-based rescue car autonomously detects and navigates towards sound sources. Its ultrasonic sensor and servo motor aid in obstacle detection and avoidance, ensuring smooth movement in complex terrains. Upon reaching the sound source, it signals its arrival with a beep. A BMP180 sensor measures environmental temperature, displaying it on a 1.3-inch I2C OLED display. This data is also sent to a user's phone via a Bluetooth module for remote monitoring, completing the simulation of an advanced, self-navigating rescue operation.

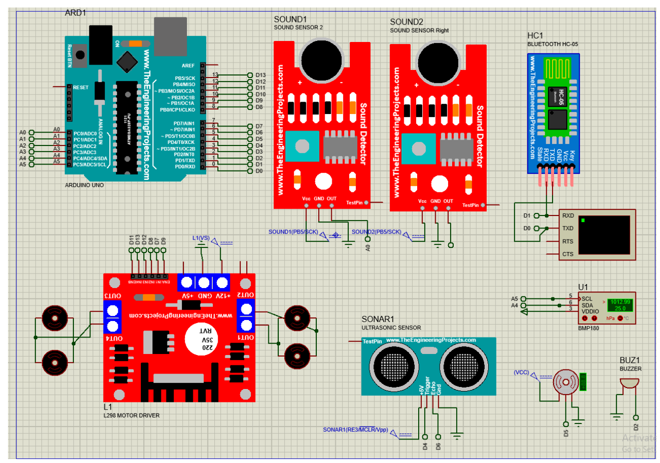

Fig. 2. Rescue Rover Simulation.

B. Process of work

There were many constraints, including

1) **Limited terrain adaptability:** The vehicle may not be able to travel over difficult terrain or over obstacles because it is built for level, even ground.
2) **Limited battery life:** The battery life of the vehicle may be reduced, particularly if it is regularly utilised in emergency situations.
3) **Limited sensor range:** The range of the ultrasonic sensor and sound detection module may be limited, which might influence the vehicle's ability to identify barriers and locate persons in need of aid.
4) **Limited cargo capacity:** The vehicle's payload capacity may be constrained, which may affect its ability to transport aid materials or other equipment
5) **Limited communication range:** Because there isn't a wireless communication module, the range may be limited, which may affect the vehicle's capacity to transfer data or communicate with emergency personnel.
6) **Limited speed:** The vehicle's size and design may limit its speed, which may hinder its ability to react swiftly to emergencies.When using the vehicle in real-world situations, these restrictions should be taken into account, and future design iterations should make an effort to address them.These limitations should be considered when deploying the vehicle in real-world

scenarios, and efforts should be made to address them in future iterations of the design.which may hinder its ability to react swiftly to emergencies.When using the vehicle in real-world situations, these restrictions should be taken into account, and future design iterations should make an effort to address them.These limitations should be considered when deploying the vehicle in real-world scenarios, and efforts should be made to address them in future iterations of the design.

V. CONCLUSION

The Rescue Rover was built successfully, and its performance was tested in a variety of emergency settings. The vehicle's sound detection technology operated successfully, allowing it to recognise noises such as individuals begging for aid or sobbing for help. The ultrasonic obstacle avoidance technology detected and avoided obstructions in the vehicle's path, guaranteeing safe and smooth travel. Bluetooth module helps to identify areas that are at risk of fire or extreme heat, which can help them to plan their response and prioritize their efforts. Overall, the Rescue Rover performed admirably and met its goals of delivering a dependable and efficient tool for emergency responders to assist individuals in need. In the future, the Rescue Rover's design and performance can be improved by including sophisticated capabilities like autonomous navigation and real-time video streaming. These enhancements may increase the vehicle's capabilities and make it even more valued.

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