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Enhancing Body Detection in CSSR Operation Using Advanced Technology

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Enhancing Body Detection in CSSR Operation Using Advanced Technology

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Abstract — This system uses an Arduino-based mobile rescue robotic vehicle system to quickly assist those stranded in natural disasters, earthquakes, floods, etc. It allows the control centre to promptly and precisely depict the changing circumstances of people in catastrophe areas, such as underground areas, so that a team of experts and medical professionals may be dispatched to the victim's location for first care before moving them to a safe location or hospital. Because an Arduino unit controls the system, the entire procedure is completed in a matter of seconds. PIR sensors are passive infrared sensors that use variations in the infrared (heat) levels released by nearby objects to identify a person's movement. Thermal radiation with a wavelength of roughly 10 microns is released by the human body. The PIR sensor receives it and manipulates it to identify people. It runs on 5V DC. By looking for a quick change in the surrounding infrared patterns, one can determine whether a human is moving. When an obstruction is detected, an Analog signal is sent to the Arduino by the obstacle sensor.

Keywords — Robotic vehicle system, Thermal radiation, Passive Infrared Sensors, Analog signal, CSSR Technique.

I INTRODUCTION

Sensor-based technologies have advanced significantly as a result of the growing demand for accurate and dependable body detection systems. This method makes use of the combined strength of several sensors to enhance the detection process, guaranteeing greater precision and resilience in a range of environmental circumstances. In this project, we connect an Arduino Nano microcontroller with a number of sensors, including temperature, infrared (IR), and ultrasonic sensors. Every sensor adds different information: the temperature sensor detects temperature changes related to human bodies, the infrared sensor detects motion or the presence of objects, and the ultrasonic sensor measures distance. As the processing center, the Arduino Nano aggregates and analyses the data using the CSSR technique to improve the effectiveness of the detection algorithm. A potent signal processing method called CSSR (Compressive Sensing and Sparse Representation) is intended to glean valuable information from data, even in cases where it is noisy or lacking. The fact that many signals, including sensor data, are sparse and may be represented with only a few significant coefficients is exploited by compressive sensing. Better data reconstruction and interpretation are made possible by this dual strategy, which makes CSSR very helpful for body detection. A methodical procedure is used when integrating the CSSR function with sensor data collection. The Arduino Nano first collects unprocessed data from the temperature, infrared, and ultrasonic sensors. The ultrasonic sensor provides distance readings, the IR sensor detects changes in infrared light, and the temperature sensor measures heat levels. Each sensor offers a distinct kind of information. By using multiple sensors, the system is guaranteed a diverse collection of data points for analysis. The first step the Arduino Nano does to clean the incoming sensor data is called preprocessing. To get the data ready for additional processing, this stage entails smoothing it, eliminating noise, and filtering out anomalies. Even in settings with high levels of interference or background noise, this combination enhances the system's detection capabilities and aids in more effective data management.

The last step is decision-making, in which the presence of a human body is ascertained by analyzing the processed data. An algorithm on the Arduino Nano determines if the gathered and processed sensor data satisfies predetermined thresholds. The system can initiate actions like sounding an alarm, capturing data, or sending an alert to a connected device if the requirements are satisfied, indicating a positive detection. There are many advantages to using the CSSR technique to improve body detection. The system can eliminate false positives and negatives by cross-verifying data from numerous sensors.

II BACKGROUD OF INVENTION

The development of body detection technology has greatly influenced cutting-edge applications in industries including robots, autonomous vehicles, healthcare, and security. Over the course of several decades, advances in computer vision, sensor technology, and artificial intelligence have all been used into the development of body detection.

1. **Sensor-Based Detection and Early Developments (1960s-1980s)**
   Motion and Infrared Sensors: Basic motion and infrared (IR) sensors were used in early detection technologies. These systems had trouble accurately identifying and differentiating between objects, but they were able to detect

movement. Radar and ultrasonic sensors are used in basic security systems to detect items and bodies. By measure environmental changes, such as radio signals or sound waves, although they are not very good at differentiating between people and objects.

2. **Pattern Recognition and Computer Vision (1990s)** New opportunities for identifying and detecting human bodies in pictures and videos were brought about by the development of digital cameras and computer vision. Pixel data could be processed by pattern recognition algorithms to find outlines and shapes that resemble the human body. However, the sophistication of these early computer vision systems was insufficient to reliably detect and identify bodies in challenging situations or in various lighting conditions.
3. **Advanced Uses in the 2020s**
   Real-Time Human Activity Recognition: By fusing motion analysis and body detection, computers can now recognize particular behaviours, such as running, walking, or falling, which has uses in surveillance and elder care. Autonomous Vehicles: By detecting and anticipating pedestrian movements, body detection enables autonomous automobiles to increase road safety. Healthcare and Biometric Monitoring: In order to help with diagnosis and rehabilitation, wearable sensors and cameras now provide body detection for tracking vital signs, posture, and movement.

Through these advancements, body detection has become a key technology in enabling intelligent systems that interact with and adapt to humans in real-world environments.

III LITERATURE SURVEY

A review of the literature on body detection in advanced technology-assisted collapsed structure search and rescue (CSAR) operations discusses the special difficulties and advancements in locating human beings beneath rubble or debris, which is essential for prompt rescue in emergency situations. In these settings, advanced body identification systems concentrate on resolving problems including poor visibility, restricted access, and the difficulty of distinguishing human bodies from non-human items.

A. Sensor Technologies for Collapsed Structure Detection

Thermal imaging and infrared (IR) cameras are being researched extensively for identifying body heat beneath debris. Their ability to distinguish warm bodies from cold environments is supported by literature, and it works particularly well in colder climates. Their drawbacks, however, become noticeable in warm settings or when thermal signatures are obscured by insulating materials (such as dense concrete).

B. Models for Computer Vision and Machine Learning

Models for Image Recognition and Classification: Convolutional neural networks (CNNs) and other advanced machine learning models, such YOLO (You Only Look Once) and Faster R-CNN, are frequently used to recognize humans in photos and videos taken by robots or drones. According to published research, these models are effective at distinguishing between human shapes and debris, and their performance may be increased by training them on datasets tailored to catastrophe situations.

C. Multispectral and Hyperspectral Imaging

By combining visible, infrared, and hyperspectral wavelengths, multispectral imaging improves body detection by recording various material reactions under debris, including particular features of human tissue, according to published research. These systems are constrained by high processing requirements, yet here are able to discriminate between human bodies and surrounding materials.

D. Identification of Human Activity with Micro-Doppler Radar

Human Movement and Posture Analysis: To identify small motions, postures, or even indications of discomfort, human activity recognition models—such as those that use LSTM or RNN—are employed. Based on minor or repetitive actions, including breathing or modest gestures, these models can be quite helpful in identifying survivors, according to the literature.

E. Drone Imaging and Sensing Platforms and Unmanned Aerial Vehicles (UAVs):

Drones with multispectral sensors, optical cameras, and infrared cameras have been thoroughly researched for their capacity to fly over collapsed areas and record thermal imaging data and real-time video. According to published research, drones are especially useful for providing aerial views, which enable rescuers to find survivors without having to venture into dangerous locations.

F. Edge Computing and Real-Time Data Processing

On-Device Processing for Lower Latency: Research highlights the application of edge computing to process data directly on robots and drones, which lowers the latency associated with data transmission to distant servers. Making decisions more quickly is made possible by real-time image and signal processing, which is essential in rescue operations where time is of the essence.

IV IMPLEMENTATION

In this prototype form, PIR, ultrasonic, temperature, and power supply sensors are the inputs that the Arduino receives. A DC motor is attached to the L293D motor driver module, which enables the LCD, buzzer, and IOT module outputs. The robot is propelled forward, backward, left, and right by a DC motor. The direction of movement of the DC motor is controlled by the L293D motor driving module. The movement's direction is determined by the written program code. A PIR sensor can be used to detect humans.

This sensor detects the 9–10 microns of heat that humans create. The detection angle of a PIR sensor is limited to 180°, meaning that it can detect in all directions except the area beneath the robot. The maximum distance that a PIR sensor can detect is 10 feet. When the robot is first started, it will go ahead. When the PIR sensor detects a human presence, it pauses for a while before turning on the LCD and buzzer to signal that a human is present. When the ultrasonic sensor detects barriers other than people, it deviates from its intended course in accordance with the algorithm.

HARDWARE REQUIRED

- Power Supply
- Temperature Sensor
- PIR Sensor
- Ultrasonic Sensor
- Arduino Uno Microcontroller
- LCD Display
- IOT Module
- 2 Axis Mechanism

SOFTWARE REQUIRED

- Arduino IDE Complier
- Proteus Testing Tool
- Embedded C

V WORKING PRINCIPLE

a) Power Supply

A transformer receives the ac voltage, which is usually 220V rms, and lowers it down to the level of the intended dc output. A basic capacitor filter first creates a dc voltage, which is subsequently converted to a full-wave rectified voltage by a diode rectifier. There is typically some ripple or ac voltage change in the resulting dc voltage. Even if the input dc voltage fluctuates or the load attached to the output dc voltage changes, a regulator circuit eliminates the ripples and maintains the same dc value. One of the widely used voltage regulator IC devices is typically used to provide this voltage regulation.

b) Transformer

The power supply voltage (0-230V) will be stepped down to a level of 0-6V by the potential transformer. The precision rectifier, which is built with the aid of an op-amp, will next be connected to the secondary of the potential transformer. Using a precision rectifier has the advantage of producing a DC peak voltage output while the remaining circuits merely produce RMS output.

c) Bridge rectifier

A circuit that converts AC to DC using four diodes placed in a bridge configuration is called a bridge rectifier. Two opposing corners get an AC voltage application, and the output is extracted from the other corners. Full-wave rectification occurs when two diodes conduct and permit the current to flow through the load in the same direction during each half-cycle of AC input. Bridge rectifiers have the benefit of producing output voltages that are almost twice as high as those of a traditional center-tapped full-wave rectifier using the same transformer. This is because it makes use of the entire secondary voltage, which results in a more efficient output.

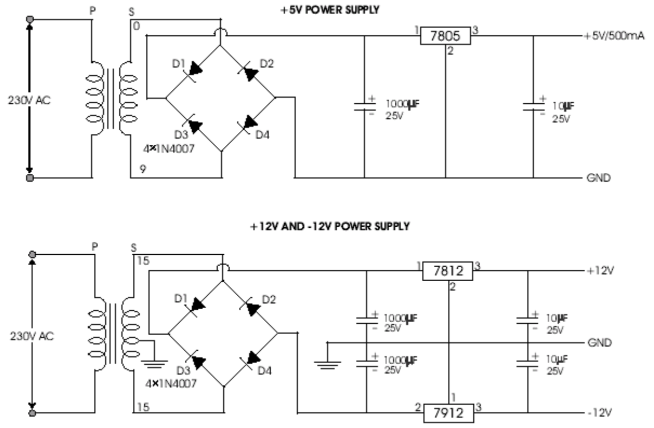


Fig.1. Circuit Diagram of Power Supply

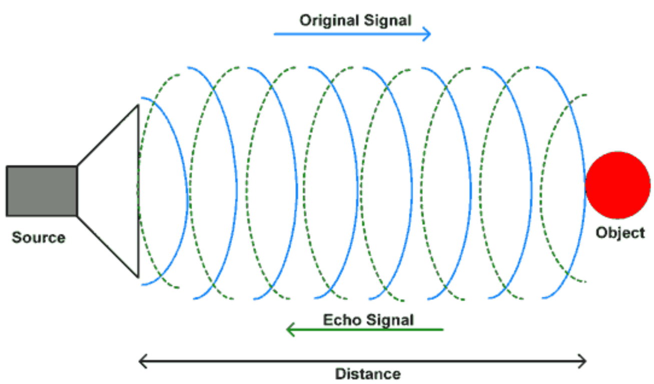
d) Ultrasonic Sensor

The HC-SR04 ultrasonic ranging module has a non-contact measurement range of 2 to 400 cm with a 3mm ranging accuracy. The modules consist of a control circuit, receiver, and ultrasonic transmitters. The fundamental idea behind work: The module automatically delivers eight 40 kHz signals using an IO trigger for a high level signal of at least 10us and determines whether a pulse signal is returned. The time from delivering the ultrasonic to receiving the signal is the time of high output IO duration if the signal returns through a high level. Test distance is equal to (high level time × sound velocity (340 M/S) / 2.

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

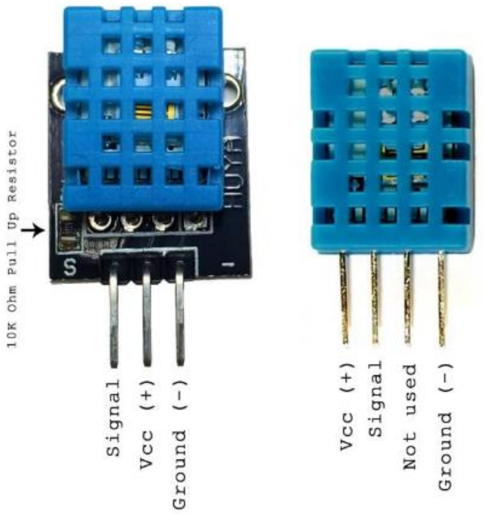
Fig 2. Electronic Wings of Ultra Sonic Sensor



e) Temperature sensor

Adding temperature and humidity information to your do-it-yourself electronics projects is a breeze with the DHT11 humidity and temperature sensor. It is ideal for home environmental management systems, farm or garden monitoring systems, and remote weather stations. Before I describe how the DHT11 monitors humidity, let me briefly review some basic information on the subject. In order to enable to utilize the DHT11 in the projects, Here demonstrate how to connect it to an Arduino and provide some sample code.

There are two different versions of the DHT11 you might come across. One type has four pins, and the other type has three pins and is mounted to a small PCB. The PCB mounted version is nice because it includes a surface mounted 10K Ohm pull up resistor for the signal line. Here are the pin outs for both versions:



f) Timing Diagram

Below is the timing diagram. To initiate the ranging, simply provide a brief 10uS pulse to the trigger input. The module will then raise its echo and send out an 8-cycle burst of ultrasonic sound at 40 kHz. An item at a distance that is proportional to both pulse width and range is called an echo. By measuring the time between delivering a trigger signal and getting an echo signal, you may determine the range. The formula is uS / 58 = centimeters or uS / 148 = inch; alternatively, the range is equal to high level time * velocity (340M/S) / 2. To avoid triggering the echo signal, we recommend using a measurement cycle of more than 60 ms.

g) Arduino Nano

A microcontroller board based on the ATmega328, the Arduino Uno has six analogue inputs, 14 digital I/O pins (six of which enable PWM), a 16 MHz crystal oscillator, a USB connector, a power jack, an ICSP header, and a reset button. Its use of an ATmega8U2 (or ATmega16U2 in the R3 version) as a USB-to-serial converter allows for greater memory and faster data transfer than previous boards. SDA/SCL pins, an IOREF pin for shield voltage adaption, and a reserved pin for later usage are all added in the R3 version. Because of its ease of use and compatibility with both new and old shields, the Uno is perfect for both professionals and enthusiasts.

```
void setup()
{
 pinMode(2,OUTPUT);
 }
void loop()
{
digitalWrite(2,HIGH); // turn LED on
delay(1000);
digitalWrite(2,LOW); // turn LED off
delay(1000);
}
```

Here is the same using a symbol to define "LED"

```
#define LED 2 // define the LED pin
void setup()
{ pinMode(LED,OUTPUT);
}
void loop()
 {
digitalWrite(LED,HIGH);
 delay(500);
digitalWrite(LED,LOW);
 delay(500);
}
```

h) Liquid Crystal Display

LCD is used to display the outcomes of the system operation such as sensing readings, motor condition. A liquid-crystal display (LCD) is a type of electronic visual display, video display, or flat panel display that makes advantage of liquid crystals' ability to modulate light. Light is not directly emitted by liquid crystals. According to the LCD standard, the data bus needs eight I/O lines and three control lines. The most widely utilized Hitachi's HD44780 controller or another similar controller serves as the foundation for character-based LCDs. This article will cover character-based LCDs, programming, how to interface them with different microcontrollers, different interfaces (8-bit/4-bit), and unique things that can do with these straightforward LCDs to give a application of new look.

Command	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description	Execution Time
Clear Display	0	0	0	0	0	0	0	0	0	1	Clears the display and returns the cursor to the home position (address 0).	82μs~1.64ms
Return Home	0	0	0	0	0	0	0	0	1	*	Returns the cursor to the home position (address 0). Also returns a shifted display to the home position. DD RAM contents remain unchanged.	40μs~1.64ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Sets the cursor move direction and enables/disables the display.	40μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Turns the display ON/OFF (D), or the cursor ON/OFF (C), and blink of the character at the cursor position (B).	40μs
Cursor & Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Moves the cursor and shifts the display without changing the DD RAM contents.	40μs
Function Set	0	0	0	0	1	DL	N$	F	*	#	Sets the data width (DL), the number of lines in the display (L), and the character font (F).	40μs
Set CG RAM Address	0	0	0	1	A_{CG}						Sets the CG RAM address. CG RAM data can be read or altered after making this setting.	40μs
Set DD RAM Address	0	0	1	A_{DD}							Sets the DD RAM address. Data may be written or read after making this setting.	40μs
Read Busy Flag & Address	0	1	BF	AC							Reads the BUSY flag (BF) indicating that an internal operation is being performed and reads the address counter contents.	1μs
Write Data to CG or DD RAM	1	0	Write Data								Writes data into DD RAM or CG RAM.	46μs
Read Data from CG or DD RAM	1	1	Read Data								Reads data from DD RAM or CG RAM.	46μs
	I/D = 1: Increment I/D = 0: Decrement S = 1: Accompanies display shift. S/C= 1: Display shift S/C = 0: cursor move R/L= 1: Shift to the right. R/L= 0: Shift to the left. DL = 1: 8 bits DL = 0: 4 bits N = 1: 2 lines N = 0: 1 line F = 1: 5x10 dots F = 0: 5 x 7 dots BF = 1: Busy BF = 0: Can accept data *# Set to 1 on 24x4 modules* *$ With KS0072 is Address Mode.*										DD RAM: Display data RAM CG RAM: Character generator RAM A_{CG}: CG RAM Address A_{DD}: DD RAM Address Corresponds to cursor address. AC: Address counter Used for both DD and CG RAM address.	Execution times are typical. If transfers are timed by software and the busy flag is not used, add 10% to the above times.

Table 1: Commands and Instruction set

i) Software for IOT

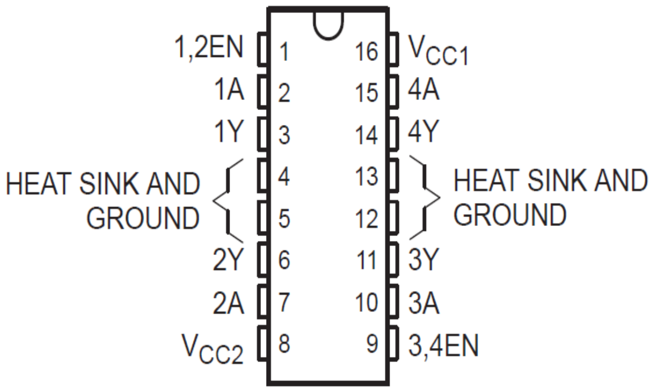
Platforms, embedded systems, partner systems, and middleware are the main ways that IoT software handles its working and action-related needs. Data collection, device integration, real-time analytics, and application and process extension within the IoT network are the responsibilities of these individual and master apps. When doing related duties, they take use of integration with vital business systems (such as scheduling, robots, ordering systems, and more).

j) Buzzer

An auditory signalling device, such as a buzzer or beeper, can be piezoelectric, mechanical, or electromechanical. Buzzers and beepers are commonly used for timers, alarm devices, and verifying user input, such as a keystroke or mouse click. Computers, printers, copiers, alarms, electronic toys, automobile electronics, telephones, timers, and other electronic devices for sound employ buzzers, which are integrated structures of electronic transducers and DC power supplies. With the help of the board and a specific sensor expansion module, an active buzzer with a 5V rated power may be immediately connected to a continuous sound, completing a straightforward circuit design that allows for "plug and play."

k) L293D Motor Driver IC

Quadruple high-current half-H drivers are the L293 and L293D. Up to 1A of bidirectional drive current can be produced by the L293 at voltages between 4.5 and 36 volts. With voltages ranging from 4.5 V to 36 V, the L293D can deliver bidirectional driving currents of up to 600 mA. Both devices are made to drive high-current/high-voltage loads in positive supply applications, including relays, solenoids, dc, and bipolar stepping motors, as well as other inductive loads.



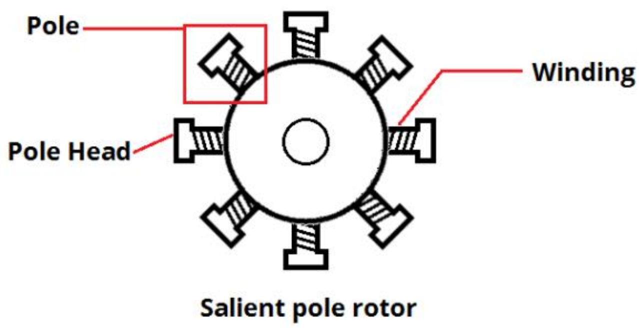
MOTOR SUPPLY AND CONTROL

Motor Supply:

As previously mentioned, a slip ring commutator is typically used to supply power to a DC motor. Asynchronous or synchronous, slip ring or externally commutated, fixed-speed or variable-speed control are the two types of commutation available for AC motors. Both AC and DC power can be used with universal motors.

Motor Control:

Direct-on-line or soft-start starters are available for fixed-speed regulated AC motors. A variety of power inverter, variable-frequency drive, or electronic commutator technologies are available for variable speed controlled AC motors. Applications for switching reluctance motors and self-commutated brushless DC motors are typically linked to the phrase "electronic commutator."



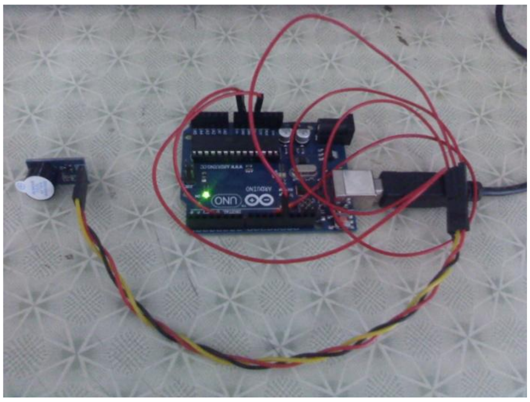
VI TESTING RESULT

1. Connect the Arduino microcontroller to the computer.
2. Connect the VCC pin of your module to the to the 5V pin of the Arduino.
3. Connect the GND pin of your module to the GND pin of the Arduino.
4. Connect the Input pin of your module to the pin 13 of the Arduino.
5. Enter this program to theArduino Integrated Development Environment (IDE):

```
int buzzer = 13;
```

```
void setup()
{
pinMode(buzzer, OUTPUT);
}
void loop()
{
digitalWrite(buzzer, HIGH);
delay(1000);
digitalWrite(buzzer, LOW);
delay(1000);
}
```

6. Lastly, click the Upload Button.



1 The sample sketch above is a blink which is also applicable for LEDs. The output is the turning on and off of the buzzer every other second. The picture above shows the setup of the module and Arduino.

III Conclusion and Future work

In this study, By presented the rudimentary concept for creating a rescue robot using a variety of rudimentary sensors, including temperature, PIR, and ultrasonic sensors, in addition to the robot mechanism. By intend to enable a basic Wi-Fi camera in the future. GPS, high-capacity motors, and long-range sensors (such as lasers, ultrasonics, or potent thermal cameras) could enhance this vehicle. In any subsequent iteration of this robot, protocols for long-distance communication will also be suggested. The creation of a fully autonomous rescue robot is our ultimate objective.

The effectiveness and efficiency of search and rescue operations are greatly increased when sophisticated body detection algorithms are incorporated into Computer Vision-based Search and Rescue (CSSR) systems. Using state-of-the-art sensor fusion and computer vision algorithms increases accuracy, speed, and dependability. Multi-modal sensor fusion, edge computing, and sophisticated machine learning models are some potential future prospects. It is possible to enhance victim outcomes, speed up rescue reaction times, and save lives by improving body detection in CSSR. To further improve CSSR capabilities, more investigation into transfer learning, adaptive thresholding, and 3D reconstruction is advised.

Using temperature, PIR, and ultrasonic sensors, we created a preliminary autonomous rescue robot prototype. GPS integration, high-capacity motors, sophisticated sensors (lasers, thermal cameras), and long-distance communication protocols are examples of future improvements. The ultimate objective is to develop a completely self-sufficient rescue robot that can perform effective search and rescue missions. By created a rudimentary sensor-equipped autonomous rescue robot prototype. For complete autonomy, future plans call for GPS, sophisticated sensors, and improved communication.

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