Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Volume 13, Issue 02, February 2024

Ai Based Human Detecting Robot for Earthquake Rescue Operation

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ABSTRACT:
Natural disasters, such as earthquakes, can have catastrophic effects on human lives and infrastructure. Earthquake rescue operations are challenging, often requiring rapid response to locate and rescue survivors trapped in the rubble. Detection by rescue workers becomes time consuming and due to the vast area, that gets affected it becomes more difficult. Hence a lot of times humans are buried among the debris, and it become impossible to detect them. A timely rescue can only save the people who are buried and wounded. Detection by rescue workers becomes time consuming and due to the vast area, that gets affected it becomes more difficult. So, the project proposes an autonomous robotic vehicle that moves in the earthquake prone area and helps in identifying the alive people and rescue operations. This project abstract outlines the development of an Artificial Intelligence-Based Human-Detecting Robot designed to assist in earthquake rescue missions. Key components of this project include machine learning, and Embedded design, integrated into a single platform to detect and locate humans trapped under debris during an earthquake. In this based live human detecting robot for earthquake rescue operation project, a new method for detecting surviving humans in destructed environments using simulated autonomous robot is proposed.

Keywords:-- **Ardunio,Human detection,Microcontroller, PIR sensor, Machine Learning, Thermal Imaging.**

I. INTRODUCTION

Natural disasters such as earthquakes and building collapses are inevitable and destructive. They often trap humans under the rubble, making it hard to locate and rescue them. Most existing models use a microcontroller and a combination of sensors, such as PIR, Ultrasonic, and IR, to detect human presence and navigate the disaster area. This project uses a special PIR sensor that emits infrared rays to sense the thermal radiation from living humans. The sensor is mounted on a robot that can move in any direction and has a geared dc motor and a stepper motor for optimal speed and accuracy. When the sensor finds a human, it sends an audio signal to the authorities for immediate assistance. Natural calamities are inevitable occurrences, posing significant threats to both life and property. Despite their unpredictable nature, advancements in intelligent rescue operations aim to mitigate their impact and save lives. Earthquakes, in particular, unleash devastating effects without discrimination, often resulting in humans being buried under debris.

Timely rescue efforts are crucial for saving lives, yet the vast affected areas and time-consuming detection processes pose challenges for rescue workers.To address these challenges, this project proposes an innovative solution: an autonomous robotic vehicle designed to navigate earthquake-prone areas and assist in identifying and rescuing survivors. Leveraging advancements in robotic technology, this project introduces a novel approach to detecting surviving humans in disaster-stricken environments using a simulated autonomous robot.The core of this robotic system lies in its sensor technology, with a primary focus on PIR sensors coupled with temperature sensors to detect the presence of living humans amidst the rubble. Additionally, wireless communication capabilities enable seamless coordination between the robotic vehicle and rescue teams, facilitating efficient and timely rescue operations. Rescue operations in earthquake-prone areas pose significant challenges for human responders, often leading to difficulties and potential hazards due to the unpredictable nature of disaster zones. Introducing robotic vehicles equipped with advanced sensing capabilities offers a promising solution to mitigate these risks and enhance efficiency in locating and rescuing trapped individuals.In this context, the utilization of Passive Infrared (PIR) sensors stands out as a pivotal technology. These sensors, adept at detecting thermal radiation emitted by living beings, serve as invaluable tools for identifying humans buried beneath rubble and debris. Strategically positioned at the forefront of the robotic vehicle, PIR sensors swiftly detect human presence and relay vital information to the control room, facilitating prompt response efforts.

II. LITERATURE REVIEW

This section provides an overview of research conducted in the field of human-detecting robots for earthquake rescue operations. Numerous authors have explored this area, contributing valuable insights and advancements to the development of such robotic systems.

The first article [1]. “RoboFI: Autonomous Path Follower Robot for Human Body Detection and Geolocalization for Search and Rescue Missions using Computer Vision and IoT” by Ahmed Imteaj, M A IsfarJubair Chowdhury, Mohammad Farshid, Abdur R Shahid in 2020: This paper gives an idea about the use of PIR sensor, which can be used for the detection of human beings and helps for the movement of the robot in the rescue operation. Even this paper deals with the application of GSM module which helps to get the proper notifications of disaster-prone area and helps to take necessary measures.

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The second article [2]. Mohit Bais, Kanupriya Madan, Ankit Bharti, Prof. Prity Yadav, "Alive Human Detection Robot" International Journal of ScientificResearch in Computer Science, Engineering and Information Technology, 2017: This paper introduce an innovative approach for detecting living humans in disaster situations. Their system integrates various sensors including PIR, temperature, vibration, and IR, along with ATMEGA16 Microcontroller, GSM, and PLC systems. These sensors collectively provide crucial data on human presence in calamity-stricken areas. PIR and IR sensors detect human presence, while obstacle sensors identify barriers. The AVR microcontroller processes analog signals and communicates human presence information via GSM modem to a remote control center. Additionally, RF transceivers enable data transmission between the robot and the control unit.

The Third article [3]. Midhat Noor Kiyani, Muhammad Uzair Masood Khan, "A Prototype of Search and Rescue Robot", Institute of Electrical and Electronics Engineers (IEEE), 2016: This paper presents a search and rescue robot prototype capable of generating shortest paths using localized and global maps. The system maps the arena and plans paths using matrix representations of the area. It can also remove obstacles from its path and accurately map the environment, including walls and floor colors. Designed for operation in both familiar and unknown environments, the robot efficiently navigates rough terrains and narrow spaces, making it suitable for real-time rescue missions.

The fourth article [4]. Zia Uddin, Mojaharul Islam, "Search and Rescue System for Alive Human Detection by Semi-autonomous Mobile Rescue Robot "International Conference on innovations in science engineering and technology, 2016: This paper proposes a robot that can detect live human beings using PIR sensor and IP camera. The robot can be controlled by joystick and RF technology and can avoid obstacles and gas leaks. The robot can analyze the conditions and confirm human presence using two levels of detection. The paper presents a reliable, cost-effective, and handy system for rescue operations using C language and ARDUINO IDE.

The fifth article [5]. R. Kabilan, K. Lakshmi Narayanan, M.Venkatesh, V. Vikram Bhaskaran, G. K. Viswanathan,S. G. Yogesh Rajan, "Live Human Detection Robot in Earthquake Conditions," Recent Trends in Intensive Computing, doi:10.3233/APC210286, 2021: This paper presents a robot designed for earthquake environments. They explore the difficulties of finding live humans among the debris. The term "intensive computing" suggests the use of advanced methods, possibly including complex algorithms for human detection. This paper shows how robotics and computing technologies can enhance disaster response in earthquake zones.

III. EXISTING METHOD

Earthquakes are very destructive and they cause a lot of damage to both human lives and property. Often, humans are trapped under the rubble and it is very hard to find them. Rescue workers have to spend a lot of time and effort to search for survivors, but the area affected by the earthquake is usually very large and complex. This makes the rescue operation more challenging and less efficient.

DRAWBACKS OF EXISTING METHOD:

- Time-consuming: Rescue workers spend a lot of time searching for survivors.
- Inefficient: Due to the vast and complex affected area, finding trapped individuals is challenging.
- Human error: Manual search methods may miss survivors, leading to potential loss of life.

IV. PROPOSED METHOD

In our proposed method for an AI-based human detecting robot for earthquake rescue operations, we have meticulously designed the system for optimal performance and reliability. Utilizing a bridge rectifier, we ensure stable power distribution at both 3V and 5V, crucial for various components. Our choice of microcontroller, Arduino, provides versatility and ease of programming.The integration of a power-on reset circuit enhances system reliability upon startup. ZigBee transceivers facilitate wireless communication, enabling remote control functionality. To drive the robotic car, motor control is achieved through relay drivers and LN293 driver IC, ensuring smooth and precise movement.A key component of our system is the passive infrared (PIR) sensor, continuously monitoring for human presence. Detected signals trigger the ATMEGA 328 controller, initiating further action. Additionally, machine learning algorithms analyze received data to determine the presence and status of living individuals, optimizing rescue efforts.The seamless exchange of information via ZigBee ensures swift communication between the robot and remote operators. Overall, our proposed method integrates advanced technology with meticulous design to enhance the efficiency and effectiveness of earthquake rescue operations.

V. BLOCK DIAGRAM

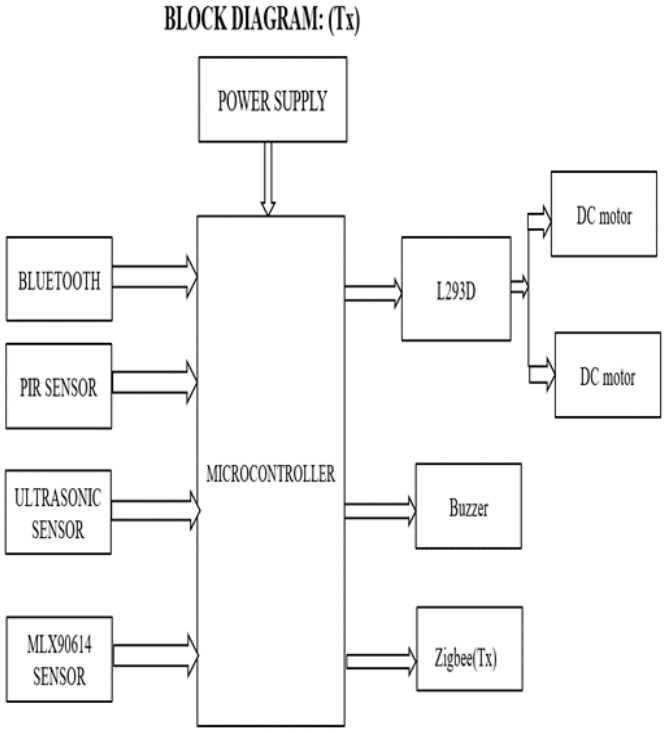

fig.1.1 Block Diagram of Transmitter section

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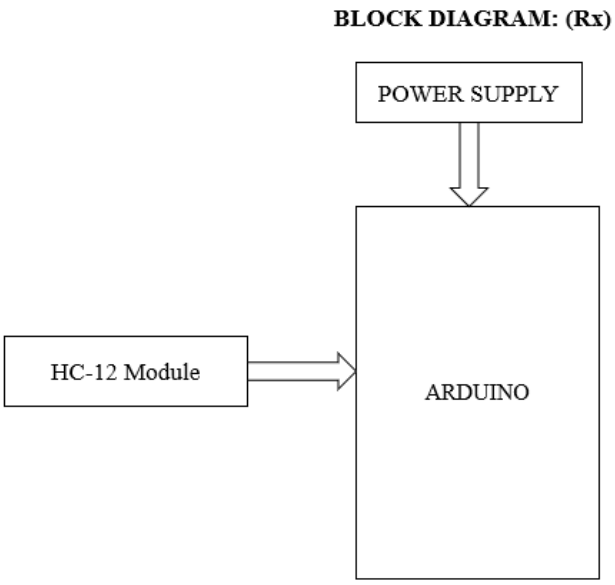

fig.1.2 Block Diagram of Reciver section

VI. CIRCUIT DIAGRAM

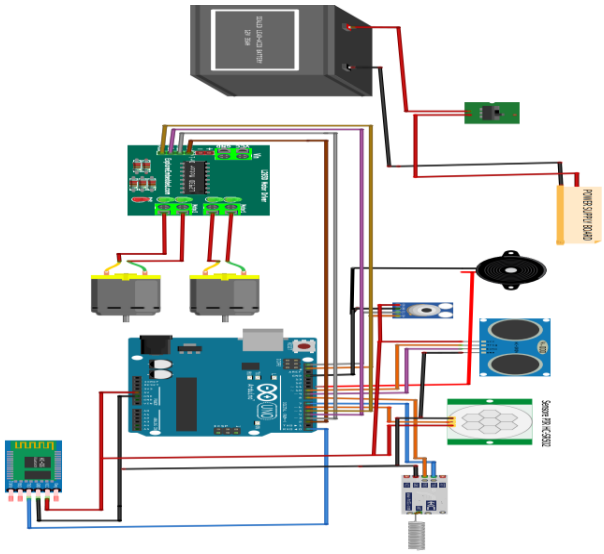

fig.2 Circuit Diagram

VII. FLOW CHART

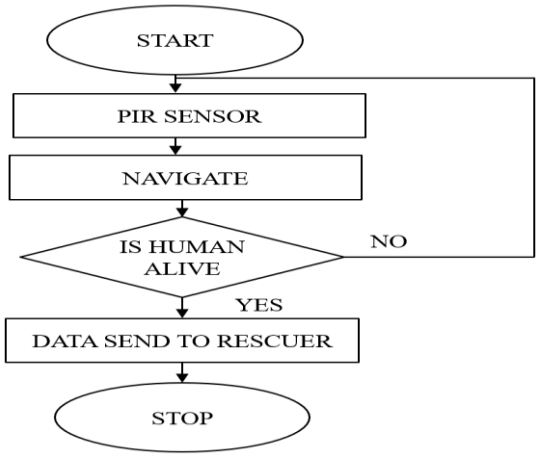

Fig.3 Flow chart

VII. COMPONENTS REQUIRED

(A).HARDWARE REQUIREMENTS

1.ARDUINO UNO

The Arduino Uno is a popular microcontroller board that serves as a foundational tool for electronics enthusiasts, engineers, educators, and hobbyists alike. At its heart is the ATmega328P microcontroller, providing processing power and flexibility for a wide range of projects. The board boasts a total of 14 digital input/output (I/O) pins, each of which can be individually programmed as either inputs or outputs, allowing for connectivity with various sensors, actuators, and other electronic components. Additionally, it features six analog input pins, labeled A0 to A5, which enable the measurement of analog signals such as voltage levels. Powering the Arduino Uno is simple and flexible. It can be powered via USB connection to a computer or a USB power adapter, making it convenient for development and testing. Alternatively, it can be powered using an external DC power supply connected to the board's DC power jack. The board also supports power input through the Vin pin, allowing for power from an external source such as a battery. Communication with the Arduino Uno is facilitated through its onboard USB interface, which enables seamless connection to a computer for programming and data exchange. The board can be programmed using the Arduino Integrated Development Environment (IDE), a user-friendly software platform that simplifies the process of writing, compiling, and uploading code to the board. Furthermore, the Arduino Uno's compatibility with a vast array of shields extends its capabilities, allowing for customization and expansion of project functionalities.

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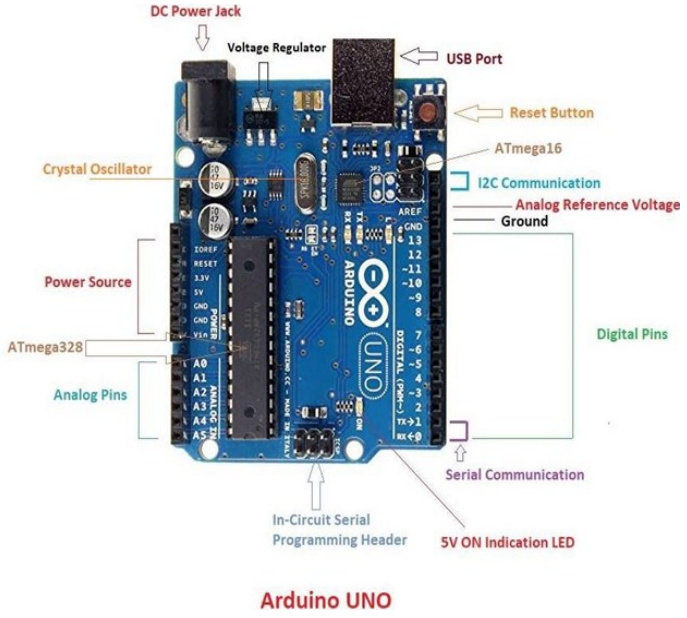

Fig.4 Ardunio UNO

2.PIR SENSOR:

A Passive Infrared (PIR) sensor is an electronic device used to detect motion by sensing changes in infrared radiation within its field of view. It is called "passive" because it does not emit any radiation itself; instead, it detects the infrared energy emitted by objects in its vicinity. PIR sensors are commonly used in security systems, automatic lighting, and other applications

where motion detection is required.The basic operation of a PIR sensor relies on the fact that all objects with a temperature above absolute zero emit infrared radiation. The sensor contains a special material known as a pyroelectric sensor, which generates a voltage when exposed to changes in infrared radiation levels. When an object moves within the sensor's detection range, it causes a change in the infrared radiation pattern, leading to a voltage signal being generated by the pyroelectric sensor.PIR sensors typically include a lens that focuses the infrared radiation onto the pyroelectric sensor, allowing it to detect motion over a specific area. The resulting change in the received infrared radiation is translated by the sensor into a change in the output voltage, which activates detection. Usually, the PIR sensors detect general movement. They do not offer specifics and information about what or who moved, but only movements of animals, people, or some other thing.

Fig.5 Pir sensor

3. MLX90614 SENSOR:

The MLX90614 sensor is an infrared thermometer sensor developed by Melexis. It enables non-contact temperature measurement using infrared radiation emitted by objects within its field of view. This sensor is widely utilized in various applications such as industrial process monitoring, automotive systems, medical devices, and consumer electronics.Operating on the principle of infrared thermometry, the MLX90614 sensor detects the thermal radiation emitted by an object and converts it into a temperature reading without making physical contact. The key feature of MLX90614 is that it is a contactless IR temperature sensor with high accuracy. So it can be used in industries to measure the temperature of moving objects like a rotating motor shaft. Due to its high accuracy and precision, it is also used in a wide range of commercial, health care, and household applications like room temperature monitoring, body temperature measurement, etc.

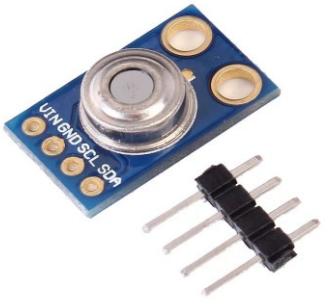

Fig.6 MLX90614 sensor

4. ULTRASONIC SENSOR:

An ultrasonic sensor is a device that can measure the distance to an object by sending and receiving sound waves that are beyond the human hearing range. It works on the principle of echo, which is the reflection of sound waves from a surface. The sensor calculates the time it takes for the sound waves to travel from the transmitter to the object and back to the receiver, and then converts it into a distance value.

Fig.7 Ultrasonic sensor

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4. L293D MOTOR DRIVER :

The L293D motor driver is a type of motor driver that is commonly used in the field of electronics and robotics. It's a dual H-bridge motor driver, meaning it can drive two DC motors simultaneously, both in forward and reverse direction. The L293D chip also has the feature to control the speed of the motor by providing PWM signals to the input pins.L293D H-bridge driver is the most commonly used driver for Bidirectional motor driving applications. This L293D IC allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Because it has two H-Bridge Circuit inside. The L293D can drive small and quiet big motors as well. There are various ways of making an H-bridge motor control circuit such as using transistors, relays, and using L293D/L298.

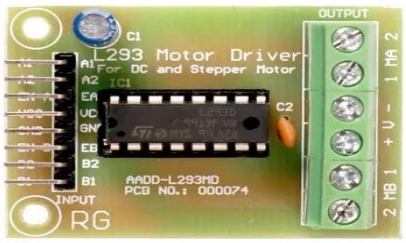

Fig.8 L293D motor driver

5. HC-05 BLUETOOTH MODULE:
Bluetooth module is a PCBA board which integrated Bluetooth functions. Bluetooth module can be used in short-distance wireless communication, which can be divided into the Bluetooth module and Bluetooth voice module according to its usage.Bluetooth module is a basic circuit set of chip which integrated Bluetooth functions and which can be used in wireless network transmission. Generally, the Bluetooth module can be divided into the following types: data transmission module, remote control module, etc. Usually, modules are the semi-finished products, which are processed on the basis of chips to make the next application easier. Bluetooth modules had a lot of applications and can be used in a variety of ways and applications. They can be used as light switch controllers, as they can be connected to Micro controllers to switch the light on or off. Thye are also used in various IOT connections.

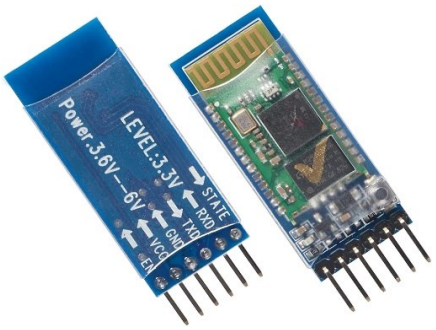

Fig.9 HC-05 Bluetooth module

6. HC-12 MODULE:
The HC-12 module, leveraging the SI4463 chip, offers versatile wireless communication capabilities suitable for a range of applications. Firstly, it enables long-range wireless serial communication, making it ideal for scenarios such as remote control of devices like drones, robotics, or remote-controlled vehicles. Secondly, it facilitates the establishment of sensor networks, allowing for seamless communication between sensor nodes in applications such as environmental monitoring, agriculture, or industrial automation. Thirdly, it supports telemetry transmission, enabling the wireless transfer of data for tasks like weather monitoring or remote data logging. Moreover, HC-12 modules find utility in wireless data transmission applications, serving as a means to establish reliable links between devices for commands or sensor data transmission.

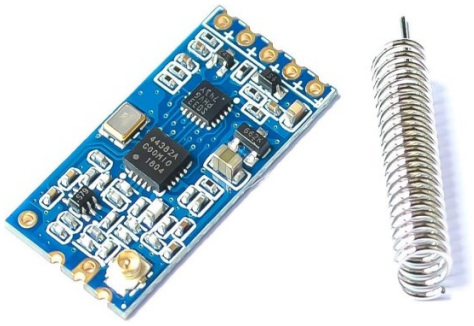

Fig.10 HC-12 Module

7. DC MOTOR:
A DC (Direct Current) motor is an electrical device that converts electrical energy into mechanical energy through the interaction of magnetic fields. These motors are widely used in various applications due to their simplicity, reliability, and controllability. Fundamentally, a DC motor consists of two main parts: the stator, which generates a magnetic field, and the rotor, which contains a coil or winding that interacts with the magnetic field to produce motion. When a current is applied to the coil in the rotor, it becomes an electromagnet, and the interaction between the magnetic fields of the stator and the rotor causes the rotor to rotate. The direction and speed of rotation can be controlled by varying the magnitude and direction of the electrical current supplied to the motor.

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Fig.11 DC motor

8. POWER SUPPLY MODULE:
A power supply module is an electronic device responsible for converting electrical energy from a power source into a form suitable for powering various electronic components or devices. These modules play a crucial role in providing stable and reliable power to ensure the proper functioning of electronic systems. Typically, a power supply module accepts an input voltage from an AC (Alternating Current) or DC (Direct Current) power source and converts it to a regulated output voltage or current suitable for the specific requirements of the connected devices.

9. BUZZER:
A buzzer is a simple yet versatile electrical device used for producing audible alerts, notifications, or alarm sounds in various electronic systems and applications. It typically consists of a housing containing a piezoelectric element or an electromagnetic coil connected to a diaphragm. When an electrical signal is applied to the buzzer, the piezoelectric element or electromagnetic coil generates vibrations that cause the diaphragm to move back and forth rapidly, producing sound waves in the surrounding air.

Fig.12 Buzzer

(B).SOFTWARE REQUIREMENTS:

1.PYTHON IDLE: Python IDLE version 3.7.0 is an integrated development environment (IDE) specifically designed for Python programming. It provides a user-friendly interface for writing, executing, and debugging Python code. With Python 3.7.0 IDLE, developers can utilize a built-in interactive shell to test code snippets and explore Python functionalities in real-time.This version of IDLE boasts features such as syntax highlighting, code completion, and a user-friendly script editor, which enhances the coding experience and promotes productivity. Additionally, Python 3.7.0 IDLE includes a robust debugger that allows developers to set breakpoints, inspect variables, and troubleshoot errors efficiently during program execution.For novice programmers, Python 3.7.0 IDLE offers comprehensive documentation and built-in help resources, facilitating learning and skill development. Furthermore, the IDE provides a file explorer for seamless project navigation and organization.Although Python 3.7.0 IDLE is well-suited for smaller projects and educational purposes, more advanced developers may opt for alternative IDEs like PyCharm or Visual Studio Code for larger and more complex projects. However, for projects developed with Python 3.7.0, IDLE serves as a reliable and efficient development environment.

VIII. RESULTS

The AI-based human detecting robot demonstrated promising performance during extensive testing in simulated earthquake scenarios. The robot successfully provides the requires result and it is effectively avoiding obstacles while traversing debris-laden terrain. The integration of AI algorithms enabled the robot to detect and classify human presence accurately in disaster areas. It provides the sign and making the buzzer sound while it detect a person presence.Real-time feedback from the robot's sensors provides valuable situational awareness to rescue teams, facilitating timely and targeted interventions.Additionally, the robot vehicle ability to emit audible alerts through the buzzer system was found to be reliable and responsive. Overall, the developed robot shows promising potential as a valuable tool for enhancing the efficiency and effectiveness of earthquake rescue operations by aiding in the detection and localization of survivors.

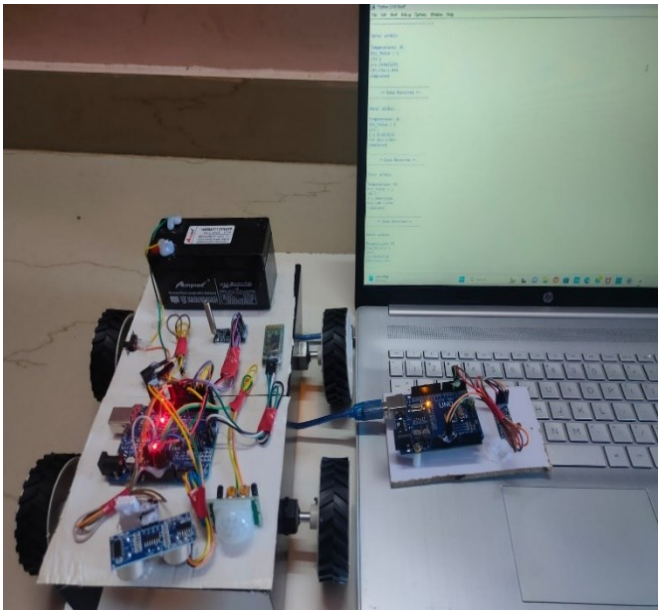

Fig.11 Hardware implementation of AI based human detecting robot for earthquake rescue operation.

International Journal of Engineering Research & Technology (IJERT)
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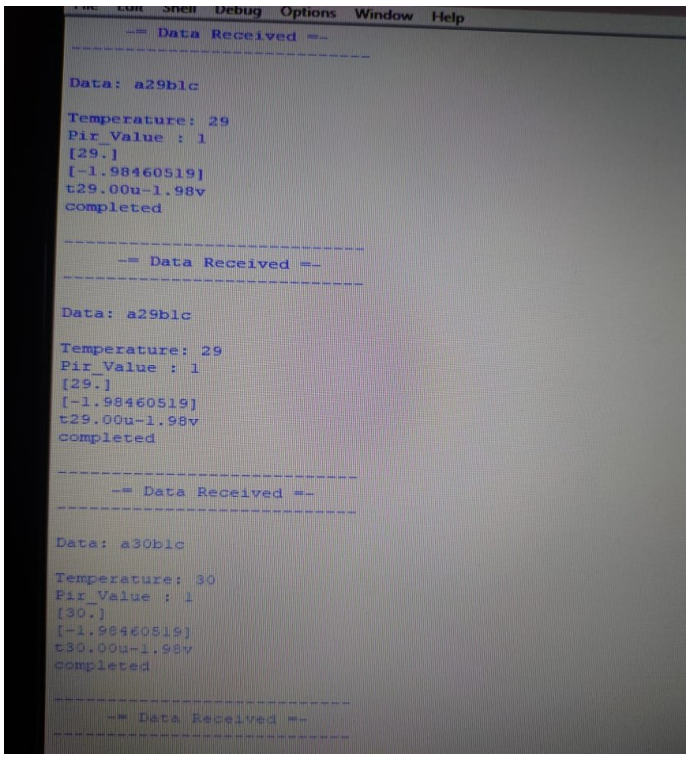

Fig.12 Data Receiveing of AI based human detecting robot for earthquake rescue operation.

IX. CONCLUSION

The goal of this work was to provide a rescue robot for human detection in a disaster environment. Though, the existing Urban Search and Rescue Robots are equipped with various sensors, but the problem with them is the cost and complexity of circuit. The sensor used in the development of this project is easily available and cost effective. Hence many life's can be saved by using this autonomous vehicle during an earthquake disaster in a short duration which becomes time consuming and unaffected if done manually. This vehicle can be improved by using high range sensors and high-capacity motors. Some more sensors like mobile phone detector, metal detector etc. can be implemented to make this vehicle more effective. This System is an effective and a safe system to ensure that there are no humans left behind in a rescue operation.

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