# Design and Implementation of Human Detection Robot for Disaster Management

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**Abstract— It has been around for a while that humans can be recognized by robots. A variety of human-detecting robots have been developed, depending on the application. It might be difficult to rescue people who are buried beneath buildings following natural disasters like earthquakes. The rescue team does detection, but it takes a while. In these situations, prompt human detection is essential. This paper describes and proposes a simple human detection robot that is operated manually and makes use of RF technology to locate individuals in an emergency. The victim may be saved by the use of these robots. By locating people in catastrophe zones where humans would have limited access, this can also assist the rescue team. Additionally, it enters zones where people are in grave danger. Instead of detection, which may be done effectively by these robots without endangering extra human lives, it helps rescue squads divert their manpower to other areas. The human detecting robot is outfitted with a number of sensors and actuators, such as thermal sensors, PIR sensors, movement sensors, and various sorts of actuators that receive inputs from these sensors and provide outputs like the location of the survivors, whether or not the survivors are alive or dead, etc.**

## INTRODUCTION

The Fukushima nuclear accident in Japan brought to light the need for thorough investigation and research of robotics capable of performing jobs under difficult circumstances. The catastrophe also spurred the defence Advanced Research Projects Agency (DARPA) to look into the usage of robots in such situations. They tried to replicate the environment and circumstances of the Fukushima tragedy by studying it. The DARPA Robotics Challenge (DRC), a robotics competition including 25 international teams competing with diverse robot platforms, was one outcome of their research. There were eight challenges in the DRC Finals that were necessary in genuine catastrophe circumstances [1]. Robots have both advantages and disadvantages. While the joint torques of small, light robots are insufficient for various tasks, humanoid and wheel-based robots are unsteady on their feet and have trouble avoiding obstacles. To overcome these problems, the DRC-HUBO+ was developed with greater mobility and manipulability than earlier robots. Additional criteria include a three-dimensional (3-D) LIDAR system for autonomy, real-time software, a light and rigid body design, sufficiently high joint torques for demanding jobs, and system longevity. Design goals included creating a framework that could support motion. We combined the benefits of humanoids and wheel-based robots to increase mobility. In instance, DRC-HUBO+ can navigate obstacles like stairs and uneven ground by walking on two legs while maintaining stability in wheel mode. Natural disaster catastrophes cannot be avoided. India has a history of being vulnerable to numerous natural disasters as a result of its geographic location. Landslides, droughts, floods, cyclones, and earthquakes are all frequent occurrences. The country's territory is susceptible to earthquakes of varying intensity to the extent of 59%, cyclones to the extent of 8%, floods to the extent of over 40 million hectares, and drought to the extent of 69%. In the final ten years of the twentieth century, natural disasters affected around thirty million people in various ways and resulted in the deaths of an average of 4344 persons each year Robots that can detect people have a number of advantages over conventional disaster response techniques. The ability of these robots to run continuously enables a constant search for survivors. Second, they can give rescue crews up-to-the-minute information, enabling quicker and more effective reaction times. Third, unlike human rescue teams, these robots are not impacted by emotions such as happiness or sadness. The capability of human detection robots to work in difficult environments like rubble and debris is another advantage. These robots have powerful vision and sensor systems that enable them to detect human vital signals even when they are blocked by materials like concrete, wood, or steel. Even when the robot travels on uneven terrain or is subjected to strong external forces. To increase its maneuverability, new arms and hands were made. An air-cooling strategy was applied to achieve this. Rescue robots are driven by many different things. For starters, tiny robots can reach spaces that are inaccessible to living things because of their small size, extreme heat, toxicity of the environment, and other issues. The effectiveness and safety of rescue efforts are a serious concern.

## LITERATURE SURVEY

One of the concepts that has been used the most in multi-robot systems to execute a variety of complex tasks, according to article [1], is cooperation. According to the chosen algorithm, a swarm of functional robots cooperates to carry out a single coordinated activity. Swarm robots have been utilized in dynamic areas where access would otherwise be challenging due to their resilient and adaptable character. Teams that respond to disasters now use robotics in addition to human labor, depending on the robots' inputs. These technologies are extremely helpful in disaster-affected areas due to their robustness and automated function. They are able to access areas that are challenging for people to get. Our goal is to develop a system that can locate any live form trapped in a situation like this and move it out of the way by making a series of coordinated movements. The behavior of the systems that were built primarily takes its cues from the behavior of swarms or groups of diverse animal species that move together or carry out tasks that would be difficult to achieve alone. The system employs bots that communicate with one another and cooperate to carry out difficult macro-level tasks by interacting locally. We must synchronize the timings of the bots in order to complete the work of coordination, which is often done by altering their local clocks. The actions of the bots should be planned out in advance in order to prevent any conflicts between their behaviors. The idea of sharing is essentially a component of bot cooperation. Resource, time, and space sharing are all examples of sharing. The master-slave relationship between the bots and temporal synchronization algorithms will assist in achieving this. The clock times of the bots will be synchronized with the master bot's clock time as part of time synchronization. The task cannot be completed by unsynchronized bots due to differing offset values. We therefore provide a method that performs the task using synchronized bots.

For the first time, in paper [2], we investigate human-robot interactions (HRI) during a genuine upstaged rescue. The data gathered during the response was subjected to a post-hoc analysis, which produced 17 findings on the influence of the environment and conditions on the HRI, including the skills exhibited and required by humans and robots, the specifics of the Urban Search and Rescue (USAR) task, the social informatics in the USAR domain, and the timing of information transmission. Through the provision of a case study for HRI in USAR based on an unstated USAR endeavor, the findings of this work have an impact on the field of robotics. On the basis of the results, eleven recommendations are given that have an effect on the domains of robotics, computer science, engineering, psychology, and rescue. These suggestions include formal representations of the state of the robot, condition of the environment, and information about what has been observed. They also urge for further study into perceptual and assistive interfaces. Rescue robots have several goals in mind. First, because of their small, extraordinary heat tolerance, environmental toxicity, etc., tiny robots can enter spaces that are inaccessible to larger living organisms. The effectiveness and safety of rescue efforts is a critical problem. We observe that robots can be replaced. Third, deploying a robot only takes a few minutes. The number of duties involved in a rescue, including search, extraction, examination, inspection, and medical treatment, require more skilled personnel than there are available.

According to the paper [3], automation is one of the growing needs in both industrial and home applications. Human labor is reduced by automation because self-operating systems take its place. By allowing information to be exchanged between various devices on a single network, the internet of things (IoT) is a platform that is expanding in popularity today. Using the internet of things, we can keep an eye on the data and protect the day. In this project, we're building a bot with a robotic arm and a temperature sensor that displays the room's temperature in real time on the

Blynk app. One of the growing needs in both industry and home applications is automation. Automation decreases human effort by substituting self-contained, automated systems for human labor. Various common protocols and machine-human interfaces are employed in this paper. This robot system is accessible remotely through the internet from several locations. They used a web browser to navigate this mobile robot and to control it. Different tasks can be carried out using a web browser from various locations. This system focuses on using cloud computing for mobile robot control. In this case, there are two servers in use. For interactive web page use, JavaScript was employed rather than dynamic HTML on AWS cloud hosting.

In this paper [4], we learn about the significant potential for natural synergies between information visualization and human-robot interaction (HRI), where information visualization focuses on designing interfaces that enable people to construct targeted knowledge through data while HRI develops interfaces that enable humans to effectively direct and/or supervise robots while also making use of the data collected by such robots. We contend that in addition to being built from a robotics centric point of view, robot interfaces must increasingly take user engagement with the data produced by robots into account. Furthermore, we point out that robotics provide exciting potential for cutting-edge VIS research, particularly in terms of discovering methods for dealing with dynamic, unpredictable, and spatiotemporal data. To take advantage of these prospects, co-innovation and up-to-date knowledge in both sectors will be necessary. In order to achieve this, we briefly review the most important rules and recommendations from the VIS community that are applicable to HRI and suggest a preliminary framework to direct potential parallel developments in HRI and VIS, comprehend HRI data tasks and activities, and identify potential connections and opportunities for further work in this field of data-centric HRI. Supporting data collecting, analysis, and human decision making is one of the main objectives of these systems, which necessitates displaying robot data in ways that facilitate quick and accurate human interpretation. However, these systems' interfaces don't always adhere to established practices for efficient data visualization.

In this study,[5] an accelerometer-based system for gesture detection allows humans to operate the car. The two microcontrollers, an ultrasonic motion sensor, and a separate analogue to digital converter circuit are suggested in this work. It will also describe how Zigbee and other communication technologies are compared. Here, a joystick is used to manually control the robot. However, this paper is behind the robot's accelerometer in terms of development. The suggested system will include an unmanned vehicle that moves automatically to address this drawback. Using a certain collection of sensors, an Arduino microcontroller, and current GSM technology, one may detect living people during natural and man-made calamities. However, this paper lags in remote locations like the desert and forests where there is no signal to communicate with the control room. System for Detecting and Tracking Alive Human Bodies This research presents information about how human people generate thermal radiation, which is picked up and manipulated by a PIR sensor to detect alive humans, using an autonomous PC-controlled rescue robot. The microprocessor received signals from PIR sensors, which it then wirelessly transmitted to the control area. In this case, stepper motors, motor drivers, and external memory buffers are utilized.

## III. METHODOLOGY

The methodology or the method used for designing the robot mainly consists of 5 major steps. These steps come in order as these define the respective order of the methods used to construct this robot.

### A. HARDWARE SETUP

The RL78 microcontroller, PIR sensor, RFID reader, HC-05 Bluetooth module, DC motor, L239 driver, buzzer, battery, and chassis will all be part of the robot's hardware setup. The microcontroller will serve as the robot's brain and direct its motions in accordance with sensor data.

### B. SENSOR CONFIGURATION

In order to detect human bodies, we use PIR sensors, and in order to gauge body temperature, we use temperature sensors. Microcontroller advances towards the human body while controlling the velocity of the motor. It will check the temperature of the human body once it is close to it. The ADC receives output from the temperature sensor. The ADC transforms the analogue input into digital bits, which are then transferred to the microcontroller where, after a short time, an SMS is sent to the predetermined numbers. Here, the RFID reader is being used to identify the soldiers using a unique number that has already been assigned to them. The TAG and name of the soldier are read when they enter a specific RFID reader, and the temperature sensor allows us to determine whether or not they are still alive. SMS messages are sent through Bluetooth module to the needed smartphone. UART is used to reprogram this module with AT commands. These all will be sent as messages or parameters to an Android device, which will produce results.

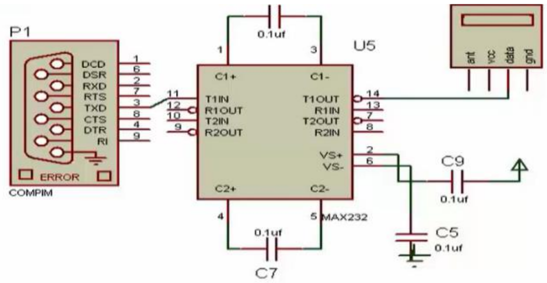


**Figure 1.** Transmitter circuit.

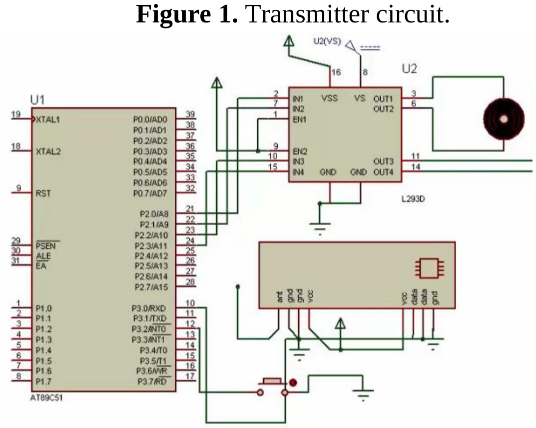


**Figure 2.** Receiver circuit.

## C.ALGORITHM

1. Initialization: All of the sensors, motors, and other hardware components will be initialized by the RL78 microcontroller.
2. Human Presence Detection: Based on body heat, the PIR sensor can identify the presence of humans. Any people who are wearing RFID tags will be recognized by the RFID reader. Both sensor inputs will be used by the RL model to determine whether people are present.
3. Movement Control: Using the sensor data, the RL model will direct the robot's motions. Depending on the RL model's choice, the L239 driver will command the DC motor to move the robot forward, backward, left, or right.
4. Aural Feedback: When the robot identifies a human, the buzzer will give the user aural feedback.
5. Remote Control: The robot can be controlled remotely thanks to the HC-05 Bluetooth module. Using a smartphone or other Bluetooth-enabled device, the user can provide commands to the robot.
6. Refinement: The RL model can be further improved in performance based on how the robot performed in the real-world disaster scenario.
7. Deployment: After the robot has been successfully tested and improved, it can be used in actual crisis situations.

All these steps can be efficiently done using a certain algorithm which must be followed throughout the work by the robot. The basic algorithm is given below.

- START
- pirState = 0;
- val=0 , p = 0;
- LCD display =1;
- l.clear();
- LCD display “Motion and Human detector”;
- delay();
- LCD display “Checking for human in range”;
- if (pirState = 1);
- LCD display “Human trace detected”;
- LED = 1;
- Buzzer = 1;
- else;
- LCD display “No human in range”;
- LED = 0;

The basic flow diagram for the above algorithm is given below

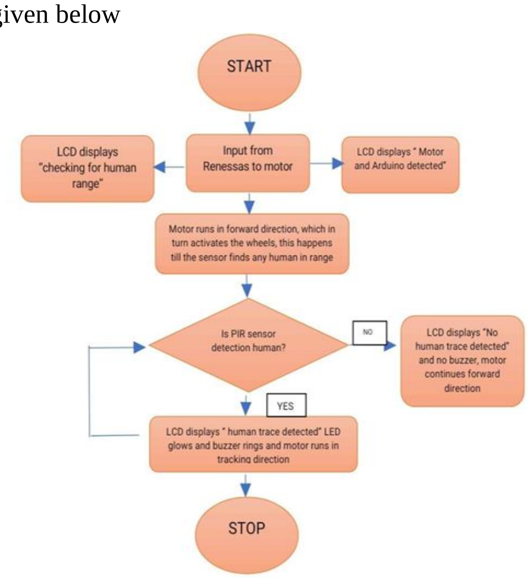


**Figure 3.** Flow diagram of the algorithm.

## IV. EXPERIMENTAL RESULTS

The horizontal range of outdoor passive infrared sensors is 108.6 degrees and the range is 10 meters. The software for the Arduino IDE (Integrated Development Environment) is compiled and debugged. The LCD display of "Checking for humans in range" appears after the PIR sensor has been activated for 20 seconds. When there are no human casualties within the aforementioned range, the LCD monitor indicates "No human detected" and the robot wheels keep moving. If human victims are discovered, the LCD displays "Unknown Human detected" and the robot wheels go backward for a certain period of time, in this case 10 seconds. This process keeps happening again and again. Additionally, when a PIR sensor detects a human victim, an LED lights and the buzzer sounds simultaneously.

The experimental results were mainly checked based on a continuous experiments between the angle of the PIR sensor and the human in front of it. Based on the results there were 4 cases of results which are explained based on the angles. Other than the angles, the RFID card was proven to be efficient as it was detected successfully and was proven to be efficient for people with the RFID tags to detect them, sound the buzzer and send the message.

Before the cases, the basic results of not detecting the human when the human is not present and the display of the serial number after punching the RFID cards were checked. It was found to be successful.

**Figure 4.** No human in front of the robot .

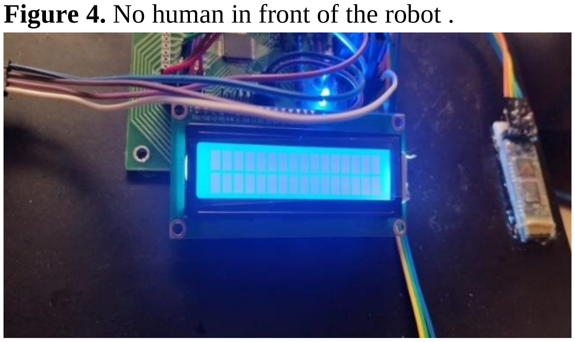

**Figure 5.** Blank LCD screen of no detection.

The figures shows that the PIR sensor was successful in not detecting the human as there no human presence Infront of it.

**Figure 6.** Punching of RFID card.


**Figure 7.** Displaying of the serial number.

The figure 6 and 7 shows that the RFID reader read the RFID card successfully and the serial number tagged with the RFID card was displayed on the LDC screen. After these basic results, the 4 cases of angles were verified and the results are shown.

### A. CASE 1

At the scene of the disaster, the robot is brought and mounted. The batteries need to be completely charged before to the process. The camera must be synchronised with the phone using Wi-Fi before being placed into the remote controller's phone holder. The robot is then manually operated by the operator inside the disaster area. After that, the robot is brought there to search for victims. Figures 8 and 9 shows that the PIR sensor cannot detect a human because they are outside of their detection range of 4-5 metres. The PIR sensor will pick up and alter the heat radiation that a human body emits in order to detect a person. Passive infrared sensors, or PIRs, detect heat. They notice a change in the temperature, which they may utilise to track human movement. The front of our model has a PIR sensor that identifies anyone within a 180-degree radius. Since the human in this scenario is not even close to the PIR sensor's detection range, neither the buzzer nor the LED light will activate as a result of the sensor's failure to identify the human.

**Figure 8.** Human in 90 degree angle with the robot.

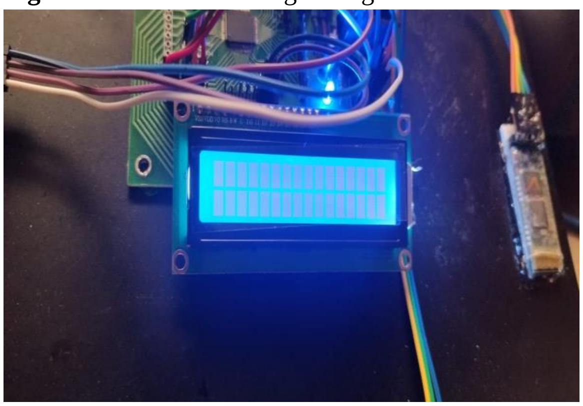

**Figure 9.** Blank LCD screen of no detection.

The above LCD screen shows blank. Therefore we can confirm that the robot does not detect a human when the PIR sensor is in the 90 degree angle with the human.

### B. CASE 2

At the scene of the disaster, the robot is brought and mounted. The batteries need to be completely charged before to the process. The camera must be synchronised with the phone using Wi-Fi before being placed into the remote controller's phone holder. The robot is then manually operated by the operator inside the disaster area. After that, the robot is brought there to search for victims. Within 4-5 metres, the PIR sensor can detect human beings. The PIR sensor will pick up and alter the heat radiation that a human body emits in order to detect a person. Passive infrared sensors, or PIRs, detect heat. PIR sensors measure infrared energy passively. They notice a change in the temperature, which they may utilise to track human movement.

Figures 10 and 11 shows what happens when a human enters the PIR sensor of the robot. The buzzer starts beeping like an alarm to indicate the presence of the human, who is in front of the sensor and indicating the same, the LED light on the robot begins to illuminate, and the LCD screen mounted on the Renesas Microcontroller starts indicating the human's presence by displaying the message "Unknown Human Detected." As we coupled the mobile with a Bluetooth device that was mounted on the model, the same information is also shown on the cell phone's screen, making it easier to recognise people. To get a better look, the robot is then physically relocated to that location. The team arrives at the scene of the disaster and begins working to help the victims. To get a better look, the robot is then physically relocated to that location. The power led is turned on to add extra lighting when there isn't enough of it. The operator spins the camera to examine the surroundings. The team arrives at the scene of the disaster and begins working to help the victims.

**Figure 10.** Human in 0 degree angle with the robot..


**Figure 11.** An unknown human is detected.

### C. CASE 3

At the scene of the disaster, the robot is brought and mounted. The batteries need to be completely charged before to the process. The camera must be synchronised with the phone using Wi-Fi before being placed into the remote controller's phone holder. The robot is then manually operated by the operator inside the disaster area. After that, the robot is brought there to search for victims. Within 4-5 metres, the PIR sensor can detect human beings. The PIR sensor will pick up and alter the heat radiation that a human body emits in order to detect a person. Passive infrared sensors, or PIRs, detect heat. They notice a change in the temperature, which they may utilise to track human movement. As seen in the image, a person is not immediately in front of the sensor, that is, not at a 180-degree angle, but rather at an angle that is just a little bit higher than 40 degrees. Since the PIR sensor detects even when a human is partially lying in front of the sensor, the angle change is less important. The robot's LED light begins to illuminate, the buzzer begins to buzz like an alert signifying the presence of a human in front of the sensor, and the LCD screen mounted on the Renesas Microcontroller begins to indicate the human's presence with the notice "Unknown Human Detected." As we coupled the mobile with a Bluetooth device that was mounted on the model, the same information is also shown on the cell phone’s screen, making it easier to recognise people. To get a better look, the robot is then physically relocated to that location.

**Figure 13.** Human in < 40 degree angle with the robot.


**Figure 12.** An unknown human is detected.

**D. CASE 4**

At the scene of the disaster, the robot is brought and mounted. The batteries need to be completely charged before to the process. The camera must be synchronised with the phone using Wi-Fi before being placed into the remote controller's phone holder. The robot is then manually operated by the operator inside the disaster area. After that, the robot is brought there to search for victims. Within 4-5 metres, the PIR sensor can detect human beings. The PIR sensor will pick up and alter the heat radiation that a human body emits in order to detect a person. Passive infrared sensors, or PIRs, detect heat. They notice a change in the temperature, which they may utilise to track human movement. Figure 6.7 shows that a human is not immediately in front of the sensor, that is, not at a 180-degree angle, but rather at an angle that can be roughly calculated to be around 20 degrees. Since the PIR sensor detects even when a human is partially lying in front of the sensor, the angle change is less important.

The LED light on the robot begins to light up, the LCD screen mounted on the Renesas Microcontroller begins to light up, and the buzzer begins to buzz like an alert to indicate the presence of the person who is in front of the sensor and signalling the same. "Unknown Human Detected" is displayed, suggesting that a human has been detected. As we coupled the mobile with a Bluetooth device that was mounted on the model, the same information is also shown on the cell phone’s screen, making it easier to recognise people.

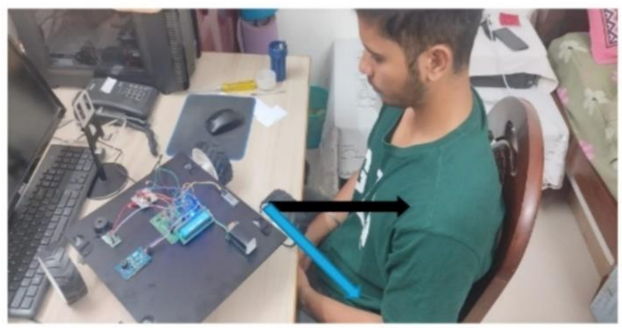

**Figure 14.** Human in > 40 degree angle with the robot.

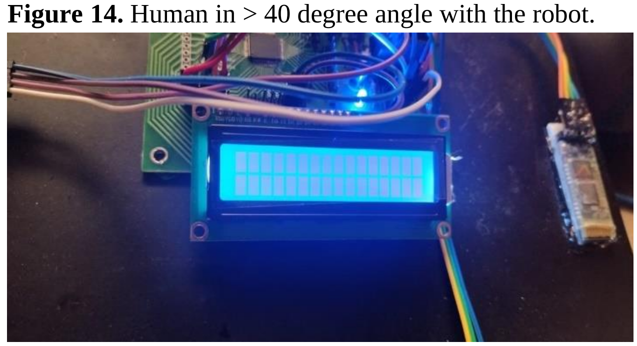

**Figure 15.** Blank LCD screen of no detection.

Therefore the above 4 results show that the detection of humans is mainly based on the angle of the PIR sensor. The angle can be adjusted manually using the remote control by a trained professional. The wrong alignment of angles will be known by the camera which will be attached right next to the PIR sensor for better judgement of the angles. Based on these results the below table can be drawn.

| CASES | ANGLE | RESULT |
|---|---|---|
| CASE 1 | 90˚ | NO HUMAN DETECTED |
| CASE 2 | 0˚ | HUMAN DETECTED |
| CASE 3 | <40˚ | HUMAN DETECTED |
| CASE 4 | >40˚ | NO HUMAN DETECTED |

**Table 1.** Results based on angles.

## V. CONCLUSION

The creation of a human detection robot for disaster management has the power to save countless lives and improve the effectiveness of disaster response operations. Such a robot might be fitted with sensors to find human survivors in locations that are hazardous or difficult for human rescuers to reach. Additionally, it might be built to endure hazardous situations like earthquakes, floods, or fires.

It is crucial to remember that the creation of such a robot necessitates careful consideration of moral and legal considerations, as well as any potential effects on the human workforce engaged in disaster response activities.

A robot of this type would also need access to precise and current information about the disaster region, which may not always be available in real-time, in order to be effective. A vital project that can greatly increase the efficiency and security of search and rescue operations in catastrophe scenarios is the development of a human detection robot. The robot can identify and find human survivors in a disaster-stricken area using cutting-edge sensors and artificial intelligence algorithms, and it can also give crucial information to rescue crews.

The precision and dependability of the robot's sensors, the robustness and adaptability of its software, and the integration of suitable communication and control systems are just a few of the variables that affect a project's success. Additionally, it is crucial to make sure the robot is made to survive adverse weather conditions and can function independently for a lengthy amount of time without human assistance.

Overall, even if a human detecting robot for disaster management has the potential to be an important aid in disaster response efforts, it should be seen as a complimentary technology rather than as a substitute for human rescuers. Together, human and robotic rescuers can increase the effectiveness and efficiency of disaster response operations, thereby saving more lives.

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## BIOGRAPHY

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Rakshith Kumar NH is attending Dayananda Sagar Academy of Technology and Management in Karnataka, India to complete his undergraduate degree in electronics and communication engineering. His current focus involves working with embedded systems, VLSI, and machine learning. He is currently in his last year. He worked effectively in a team of four to undertake research and development on an audible glove utilizing Arduino.

Pavan Singh L is a 21-year-old Electronics and Communication Engineering student from Udupi who is now enrolled in his fourth year of study at the Dayananda Sagar Academy of Technology and Management. He is an energetic and perceptive person who constantly adopts a humble attitude when working to accomplish his goals. Pavan is renowned for his upbeat outlook and commitment to achieving both his academic and personal objectives

Suhas S is an engineering student at Dayananda Sagar Academy of Technology and Management who is currently 22 years old and in his fourth year of engineering. He is working on a second scholarly project after finishing the first one. Suhas is renowned for being a modest and outgoing individual who enjoys interacting with others. He consistently works hard and is goal-oriented in his pursuit of his goals

Rajeev SP is a student at Dayanand Sagar Academy of Technology and Management who is pursuing electronics and communication engineering in his fourth year. He has high aspirations for his future. A skilled individual and productive teammate, this 21-year-old boy has developed over the course of four years of projects, seminars, and research. Rajeev firmly believes in the importance of social work and feels that helping people improve their life is more valuable than any financial reward.