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AUTONOMOUS MOBILE RESCUE ROBOT IN DISASTER ZONES

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Abstract - *Robotics has become a rapidly growing science that will enter the life of all classes of people. A project that uses robotics and detection method to help people and rescuers at the time of disasters by detecting alive human beings is proposed. Natural calamities like Earthquakes, Tsunami and man-made disasters bomb explosion, building collapse often occur and they cannot be stopped. They produce a devastating effect and find no difference among human and material. Therefore at that time humans are buried among the detritus and it becomes impossible to detect them. Only a timely rescue can only save people, who are buried and wounded. Detection by rescue workers like policeman, fire fighters and medical services is time consuming because of the vast area that gets affected. Human rescuers must make quick decisions under stress and try to get victims to safety at their own risk. They need to find the location, status of victims and the stability of the structures as fast and early as possible so that medics and fire fighters can enter the disaster area and save the victims. This project proposes a mobile robotic vehicle that moves in the disaster prone area for detecting humans in such devastating environments and helps to identify the victims during the rescue operations.*

***Key Words*: Rescue Robot, Pick and Place Operation, Human Detection, Blynk server.**

1. INTRODUCTION

Nowadays, with the advancement of technology and the emergence of new sciences, the needs of humankind have changed. Robotics is one of the sciences responding to such needs. It has made great progress and moved from fiction to reality. Every year, various collapse of man-made structures such as bridges, buildings and also natural disasters like Earthquake, landslides, floods occur in different parts of the world. The Urban search and Rescue (USAR) says, the probability of saving a victim is high only within the first 48 hours of rescue operation and then the probability becomes Zero. In such cases, humans are being trapped in the cavities created by collapsed building either in conscious or unconscious state. One of the major Natural disaster (floods) that took place in August 2019, in Karnataka resulted in a huge loss of Human lives and property. A recent collapse of building at Mumbai in July-2019 claimed nearly 14 lives. In the time of rescue operation, fire fighters, policemen and medical assistance are deployed. These people are exposed to very dangerous situations caused by the destructed environment they work in like collapsed buildings, landslides, floods, etc.

So, there is a chance for the rescuer to become a victim who needs to be rescued. It means the rescue operation imposes a substantial risk on rescue personnel themselves. So, from this point of view there is a need to look for an alternative to Human rescuers. This has always been a great challenge. Thanks to the new communication and control technologies, the robot identifies and rescues the victims of disasters such as floods, earthquakes and other natural disasters during the rescue operation.

The design for this rescue robot is described in four sections: Mechanics section, Electronics section, Software section, Communication system.

Mechanics section includes the mechanical design and transmission systems along with its specific features. Electronics section includes the control circuit design, start-up circuits, power supplies and the sensors used in the rescue robot.

Software section discusses the control interfaces, software systems and data control, analysis and transfer. Communication system is an important part and it deals with the data management and transmission in both hardware and software that are used.

2. OBJECTIVES

- Accurately detect victims during any disaster using the proposed detection method.
- Replace the Rescuer by the Robot, as there are chances that the people who are sent to find the victims in hazardous areas have to risk their own lives during the rescue operation.
- Implement a unmanned rescue robot which performs automatic human detection and Manual pick and place operation.

3. METHODOLOGY

- The main purpose of the robot is to detect alive human beings after the occurrence of natural calamities using PIR (Passive Infrared Ray) sensor. Any alive body with a temperature above absolute temperature emits radiations. The robot based system will sense these radiation of human being and it uses the sensed signal to communicate to the control section of the robot.

- The robot has a sophisticated electronic system composed of several components like sensors and controllers. Mechanical system consists of motors and drivers system. According to the mechanical requirements and the motors that are decided to be used, there is a need for the drivers that can create an interface between the hardware and software of the robot. The type of driver which is used can receive all kinds of control pulse including PWM, RC, etc.

- The systems consists of various sensors to monitor the weather conditions like temperature, humidity and pressure through wireless technologies.

- Pick and Place robot is the one which is used to pick up an object and place it in the desired location using the following method:

  (i) Mechanical Gripper mechanism: Gripper is used to grasp the object with its mechanically operated fingers. It consists of two fingers which can open and close to pick and hold a range of small objects. Fingers can be easily removed and replaced.

  (ii) Vacuum Gripper mechanism: Pick and place robots for electronic components and for large objects like car windscreens, will often use very simple vacuum grippers. These are very simple devices, but can hold very large loads provided the surface is smooth enough to ensure suction.

4. LITERATURE SURVEY

- **Shwetha R and Dr. Chethan H K** has done a work on designing an economical robot, which works using AVR, MCU, PIR sensor. This robot senses the human body temperature using PIR sensor and an alarm/indicator is used to indicate the signal when it detects alive body and this message is sent through SMS using GSM technology to enable rescue operation.

- **Mauricio Correa Et al.** has given the concept of enabling robots to detect and identify humans in domestic environment. This work was done with the aid of Thermal and Visual Information sources that were integrated to detect humans and further processed to verify it.

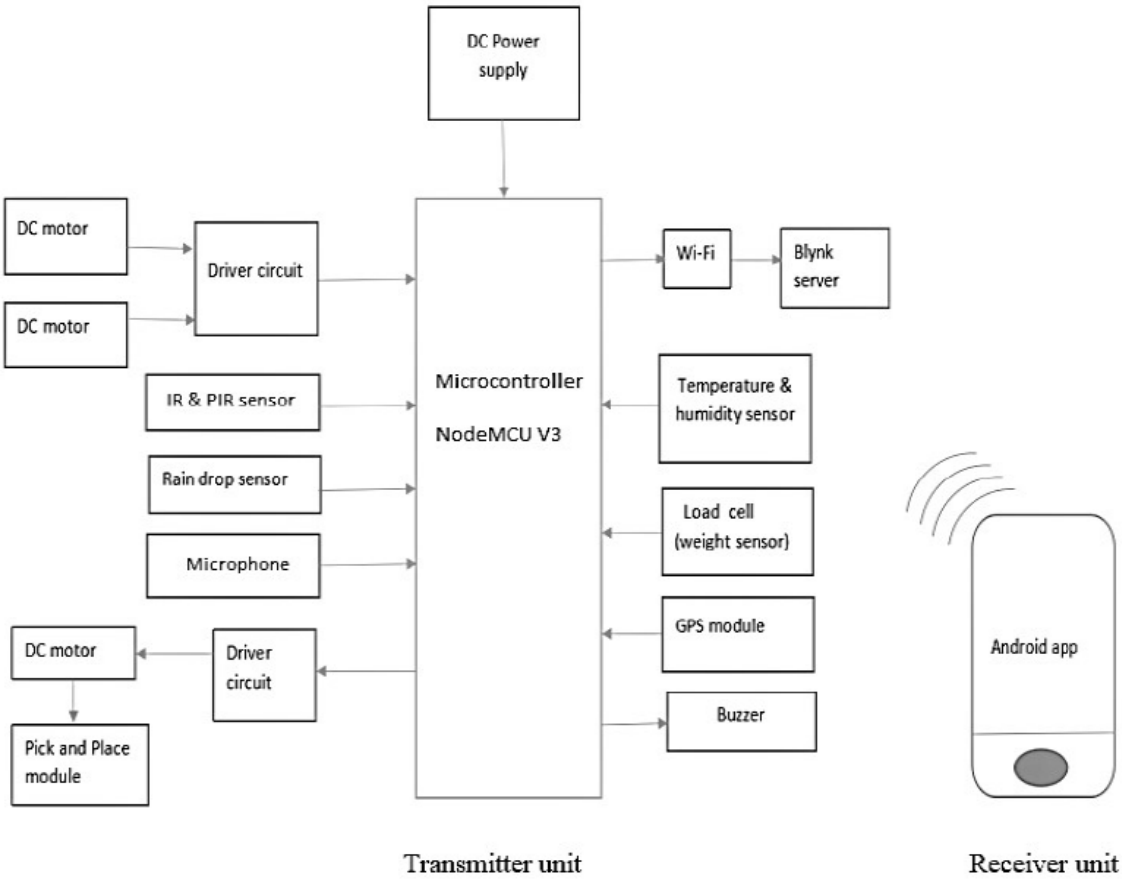
- **Wasif Naeem Et al.** has presented an initial study of the autopilot development of an unmanned surface vehicle (USV). The USV named Springer is being developed to carry out pollutant tracking, and environmental and hydrographic surveys in rivers, reservoirs, inland waterways and coastal waters, particularly where shallow waters prevail. The catamaran shaped autonomous vessel is modelled as a two input, single output system whereas the autopilot selected is a genetic algorithm based model predictive controller (MPC). The USV dynamic model is obtained using system Identification techniques. Simulation results depicting the autopilot performance in response to changes in the desired course are demonstrated.

- **Usha Tiwari Et al.** has explained about designing a Robot to navigate in the rubble with various sensors. This method used 2 methods to detect alive human, one is IR radiation emerging from the live humans and other is using the sound or cry for the help made from the humans.

- **Amon Tunwannarux Et al.** has presented a rescue robot .It has a double track robot system, it is good for unstructured landscape and able to climb over the pile of collapse. This robot is equipped with a lot of sensors such as IR temperature sensors, distance sensors, odometer dsensors,pitch/roll,compass sensor, three pan/tilt CCD cameras and Voice sensor. The double track mechanism of the robot wheels and information provided about various sensors are mainly referred.

- **Yogesh V. Bangalkar and S. M. Kharad** has presented a prototype robot which is extensively useful for military applications. PIR sensor is used to detect human. A Passive Infra-Red sensor is an electronic device which measures infrared light radiating from objects in its field of interpretation. Seeming motion is detected when an infrared source with one temperature, such as human, passes in noticeable of an infrared source with another temperature, it detects. It acts as a motion finder. Concepts like GPS tracking mechanism, Forward and reverse direction movement using geared motors are also discussed in this paper.

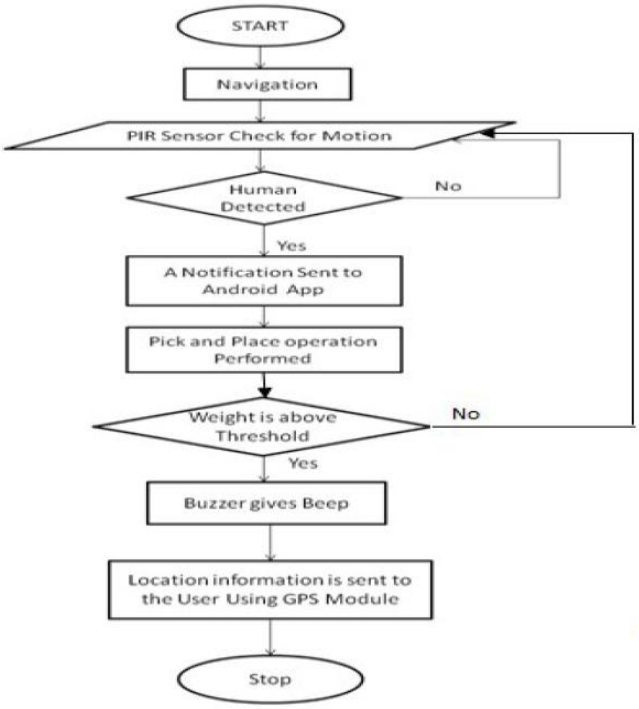
5. BLOCK DIAGRAM



This system consists of Transmitter and Receiver unit, where Transmitter unit consists of DC motor, Driver circuit and Microcontroller mounted with various sensors. Receiver unit consists of Android application which gives alert notification when PIR sensor detects alive human beings. As soon as the notification is received, Pick & place module is used pick the alive human beings into the rescue robot vehicle. Load cell is used to check whether the vehicle is overloaded or not using a buzzer. Buzzer gives a beep sound when the vehicle is over loaded. Rain drop sensor detects the rain, Temperature & humidity sensor gives the information about the changes in weather conditions. IR sensor detects the obstacles. GPS module is used track the location of the vehicle.

6. FLOWCHART

When the robot is navigating on land or water surface, if the PIR sensor detects a motion signal in its surrounding, then notification saying 'Human detected' is sent to the Android app and initiates Pick and Place operation. While Performing Pick and Place operation weight on the robot is monitored using a load cell. If weight is above the threshold weight, then the buzzer gives Beep and Location information is sent to the user using GPS module. If no human is detected, then the rescue robot keeps moving to check motion.



7. RESULT

The Autonomous mobile rescue robot mainly consists of detection unit, pick and place unit and control unit. When the rescue robot is set ON, the control unit operates the Movement of the rescue robot using a Wi-Fi enabled android application remotely. The android application provides four keys, which are used to move the robot forward, backward, left and right. The control unit also consists of a GPS module to track the location of the robot by providing longitude and latitude values.

The detection unit consists of IR sensor, PIR sensor and Sound sensor. IR sensor is used to detect the obstacles coming in the way of the robot by transmitting and receiving the infrared signal. When IR sensor detects an object, a notification stating "Object detected" is sent to the mobile using android application.

PIR sensor and Sound sensor is used to detect victims in the disaster zones. PIR sensor senses the heat emitted by the human body to detect the victims whereas the Sound sensor also called as Microphone senses the voice in the form of audio signal to detect the victims. When PIR sensor or Sound sensor detects the victim, a notification stating "Human detected" is sent to the mobile application.

Pick and place unit consists of a pick and place module and a cabin with load cell in rescue robot. When a notification stating "Human detected" is received, a manual controlled human picking operation is performed with the help of Wi-Fi enabled android application. After picking, the victim is safely placed inside the cabin and the load cell monitors the weight in the cabin. When the weight in the cabin exceeds the threshold value, an alert message is given to the rescue team in the form of a buzzer beep sound.

8. APPLICATIONS AND ADVANTAGES

8.1 APPLICATIONS

- In Disaster zones (whether it is natural or man-made disaster), rescue robot is used to save the victims in hazardous situation.
- In military applications to detect the presence of militants or human beings.
- Rescue robot is an unmanned vehicle which has the capacity to pick and place the victims into the vehicle to reach the safe place.
- It can predict rainfall and changes in weather conditions like temperature and humidity.
- Robots can work for extended duration without human intervention.

8.2 ADVANTAGES

- Rescue robots are used to search for victims & survivors in Disaster Zones.
- Rescue robots can save the people lives with less time consumption. They are stronger to carry more people in a single run to save lives.
- Rescue robots can carry out duties similar to human duties without the actual danger to human lives in Hazardous environment.
- Robots can rescue survivors in any event and they can also save soldiers who have fallen in battle. The rescue robots are excellent evidence for machine intelligence.

9. CONCLUSIONS

The goal of this project is to provide a rescue robot which is capable of saving the lives of victims in the disaster environment. During disasters, the main purpose of rescue Operation is to rescue the large number of people in the shortest time, while minimizing the risk to rescuers.

The existing rescue robots are capable of detecting victims but they alone are not sufficient to save the victim. Instead, it requires a rescuer to get the victim out from the hazardous situation. This project proposes a new method for detecting and rescuing the surviving humans in destructed environment using an autonomous mobile rescue robot. The robot uses three units to perform this operation and these three units are inter-related to each other. The first unit is the detection unit, which moves into the debris and searches for the alive Humans. The second unit is the pick and place unit, it manually controls the pick and place operation performed on the victims to rescue them without the help of a rescuer. The third unit is the control unit, which is used to control the movement of rescue robot. This robot is equipped with various sensors to monitor rainfall, water flow, temperature and humidity. The sensors used in the development of this project are easily available and cost effective than the existing Urban Search and Rescue Robots.

10. FUTURE SCOPE

This rescue robot is developed on small scale and is cost and energy efficient. It has bright and wide future because of its capability to save large number of people in the short time by minimizing the risk to rescuers. Robot can further be equipped with camera and speaker or recorder to interact with the victims and assure them of nearby help. Adding more number of DC motors to the rescue robot can further enhance the movement and speed of the robot. This complete system can be made automated by using high technology.

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