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Microcontroller Based Autonomous Robot System (MARS) for Rescuing Alive Human

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Abstract:
In this paper, a revised approach is introduced for detecting and rescuing alive humans in destructed environments such as earthquake, flood, etc. using an autonomous robot. An automated robotic system is practicable in the detection of human beings in an unmanned area. In the destructed environments, to detect the person still in existence the robot must include sensors. In the system considered here, Passive Infra-Red (PIR) sensors are used for detecting the persons who are alive. Further, in order to analyze and watch the condition of the human body lively, wireless camera is used. Movement of the robot is controlled by another set of Infra-Red (IR) sensors according to the input from PIR sensors and robotic arm is used to remove the debris and save the valuable human life. The control of its arm to eradicate the debris is employed by intelligent algorithm. This automated robotic system affords better performance in detecting and rescuing alive human beings in devastated environments with relatively fast and cost effective way.

Keywords*: Autonomous robot, Infra-Red (IR) Sensors, Passive Infra-Red (PIR) Sensors, Robotic Arm, Wireless camera*

1. Introduction

Nowadays, disasters occur often due to nature as well as human induction. Disasters like earthquake, flood, cyclone, etc., are caused by nature. In addition to natural disaster, the humans make disaster such as accidents in transportation, industries and also fire accidents. During such disasters, the humans will suffer a lot. Many lose their lives because of not begin treated in time even though different services for rescuing human beings like fire brigades, medical personnel, police are provided by the field of Urban Search and Rescue (USAR). The probability is high within the first forty eight hours of the rescue process for saving a human from danger; afterwards the probability of rescuing that human becomes virtually zero.

Usually, the rescue operation is carried out by humans along with the help of trained dogs. But it is not possible for highly complicated destructed areas due to disaster like war field, earthquake, etc. In such condition the autonomous robotic systems are very much useful in rescuing the valuable human lives. The main advantage of using robots is that they never get tired or exhausted and also process well in the inconvenient locations. The importance of using autonomous robot in detection and rescue operations is to reduce the human loss due to natural and human induced disasters, to reduce the risk involved for the rescuer and also to provide rescue operation where human reach is impossible.

Microcontroller based autonomous robot system for rescuing alive human (MARS) robot will identify live human being under debris in earth quake or other natural calamities and save the most valuable human life. Detection of live human being and movement of MARS is done making use of sensors, which detects any motion in its surrounding and acts accordingly. Here, PIR sensor will send the signal for human detection through microcontroller and MARS will be moving near to the victim. Once the PIR sensor detects human, IR sensor will gets activated. After reaching human one may use MARS arm to remove the debris.

This literature review explores some basic knowledge about motion detection and tracking, detecting surviving human using simulated autonomous robot, easily available and cost effective sensors and outline of robotics competition in rescue techniques.

Greer, Kerrow and Abrantes represented a thorough understanding of the “Urban Disaster Environment and an Appreciation for Traditional Search and Rescue Techniques” dealt with determining the success of a hovering robot solution. In this paper, search and rescue environment is described, the applications of robots in urban search and rescue, an outline of robotic competitions in simulating a real rescue environment is described.

The paper by Rufaida Shamroukh and Fahed Awad on "Detection of Surviving Humans in Destructed Environments using a Simulated Autonomous Robot", dealt about a new method for detecting surviving humans in destructed environments using simulated autonomous robot. In this the robot uses two levels of sensing in order to achieve higher cost-effectiveness in the detecting process in terms of the actual cost of equipment, the processing cost, the communication cost, the storage cost, and the power cost.
The first level is a PIR sensor that is used as the primary sensor in order to detect the existence of living humans in a scene. The PIR sensor uses the body heat radiation in detecting a living human.
The second level is a human body shape sensor. This level uses low-cost web camera with simple image processing via neural networks technique in order to confirm the existence of a human shape.
The robot is assumed to be equipped with a simple IR ranger sensor in order to avoid obstacles and a wireless communication link in order to communicate with the rescue team whenever a need arises. The neural network was trained on 500 images of different human positions until it reached an acceptable detection accuracy of about 84%.
Research by Sandeep Bhatia, Hardeep Singh Dhillon and Nitin Kumar on "Alive Human Body Detection system using an Autonomous Mobile Rescue Robot", provide a low cost 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. The sensors used in the development of this project are easily available and cost effective.
By Xiaohu Lv and Yongxin Liu on "Design of Human Motion Detection and Tracking Robot Based on Pyroelectric Infrared Sensor", a hexapod crawling robot is designed. It detects and tracks moving human body really and successfully. The whole system is low-cost, effective and reliable. The detection programs where the in ocular PIR sensors are selected make it able to timely and accurately get the infrared information of the sporting human body inside of viewing field.

2. System Description

The Microcontroller based autonomous robot system for rescuing alive human (MARS) robotic system is designed with the association of sensors, robotic arm and wireless camera. Figure 1 elucidates the block diagram of MARS in which the microcontroller acts as the heart of it along with the sensors, arm control and wireless camera. This robot uses two level sensing processes such as,
In the first level, it uses PIR as the primary sensor which is used to detect the existence of live human beings in disaster field.
In the second level, an IR sensor is employed to detect any obstacles in the path.
Based on the sensors output the robotic movement is controlled by the controller. Then the robotic arm is used to remove the debris based on second level sensing output. The wireless camera is also included which provides live video of destructed area and also helps to view the condition of human beings.

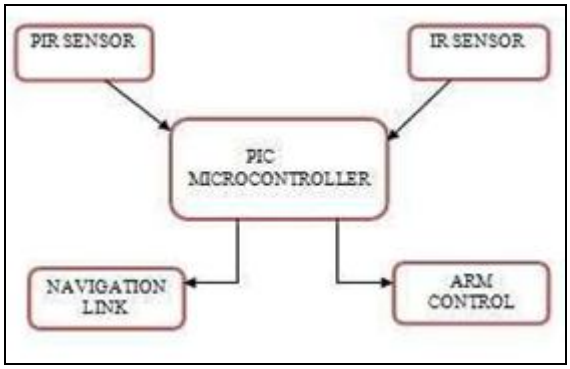

Figure 1: Block diagram of MARS

3. Flow Chart Overview

Figure 2 shows the flow chart for MARS. Initially, the PIR sensor is used to calibrate and detect the presence of existence of human beings in the disaster regions. If it provide positive output, then the robot starts to navigate otherwise it again senses for human presence and process continues. Then after detecting the alive human, the robot navigates and activates IR sensor. After activating the IR sensor it checks for obstacles in the path, if no obstacle is present then the robot continues the rescuing process otherwise it change the direction and check for obstacles and continue the process of rescuing the alive human beings by removing the debris using MARS arm.

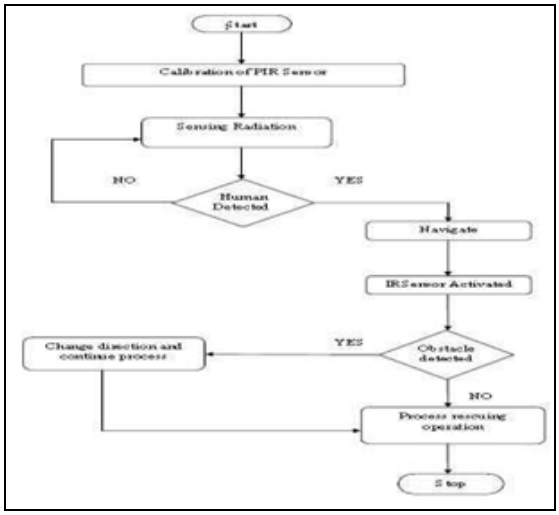

Figure 2: Flow chart for MARS

4. Algorithm for Sensing

Two PIR Sensors are used to sense humans. The angle for sensing alive human is 45-60 degrees. Sensing algorithm is explained below

In order to cover a wide area, two PIR sensors are used and the cutoff level is chosen.

Above the cutoff level, the degree of sensing is high.

For a moment, only one PIR sensor will sense the radiation.

This algorithm narrows down the sensing radiation efficiently and quickly. Two sensors sense the radiations but at a time only one sensor will serve, after completing the process next sensor will continue the process.

5. Results and Discussions

MARS is equipped with following sensors:

- PIR sensor for human detection.
- IR sensor to detect the obstacles

Figure.3 shows miniature MARS Robot. MARS activation is based on the outputs of the PIR and IR sensors. When the PIR sensor detects the alive human the robot follows specific pattern based on the control program and activates the IR sensor that helps to detect obstacles which also follows the control program and process the rescue operation by making use of the robot arm to remove the debris. Embedded C programming is used to stimulate the robot.

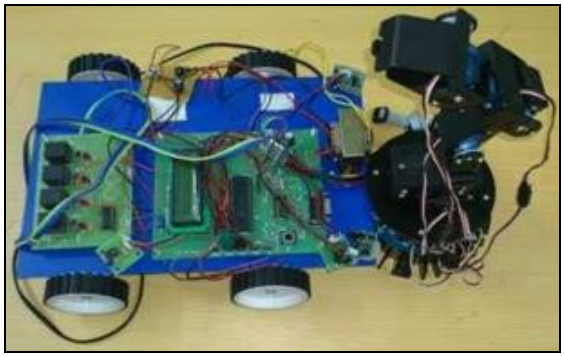

Figure 3: Miniature MARS Robot

6. Conclusion

This paper introduces a microcontroller based autonomous robot system, used for detecting and rescuing the existing human beings from the destructed areas in which the usage of human rescue service is highly difficult or impossible. By making use of sensors and robotic arm it performs better rescue operation. Further, it employs two level of sensing, though which higher cost-effectiveness would be achieved and the robotic arm supports to rescue the victim faster by removing the debris. Thus the considered robotic system performs better in detecting and rescuing humans from destructed areas with faster rate and also with cost-effectiveness.

7. Future Scope

In future, this MARS robot could be designed with alteration in its shape such that it can move through highly complicated regions or to ascend over the obstacles. It could also be aimed at flying in order to made detection and rescue operation further faster.

8. References

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