Alive Human Body Detection system using a Autonomous Mobile Rescue Robot

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Abstract— *In this paper, a new approach for detecting alive humans in destructed environments using a autonomous robot is proposed. Alive human body detection system proposed a monitoring system using ultrasonic sensors and camera to record, transmit and analyze conditions of human body. The task of identify human being in rescue operations is difficult for the robotic agent but it is simple for the human agent. In order to detect a human body, an autonomous robot must be equipped with a specific set of sensors that provide information about the presence of a person in the environment around. This work describes a autonomous robot for rescue operations. The proposed system uses an ultrasonic sensor in order to detect the existence of living humans and a low-cost camera in order to acquire a video of the scene as needed. Additional, other sensors include temperature, fire and metal detector works as bomb sensor to detect the presence of bomb in Warfield and in rescue operations. Having detected a sign of a living human, the ultrasonic sensor Triggers the camera to show live scene. The video is then displayed on the screen. This approach requires a relatively small number of data to be acquired and processed during the rescue operation. This way, the real-time cost of processing and data transmission is considerably reduced. This system has the potential to achieve high performance in detecting alive humans in devastated environments relatively quickly and cost-effectively. The detection depending on a number of factors such as the body position and the light intensity of the scene. Results show that the system provides an efficient way to track human motion. The aim of this article is to present our experience with various sensors designed and developed.*

Keywords — *Autonomous mobile robot, Mobile Robot, Motion detection, Rescue, Robotics, ultrasonic sensor, Urban Search and Rescue.*

I. Introduction

Disasters can disrupt economic and social balance of the society. Because of high rise buildings and other manmade structures urban and industrial areas can be considered to be more susceptible to disasters. These disasters can be categorized into natural and human induced disasters. Natural disasters include floods, storms, cyclones, bushfires and earthquakes where as besides natural disasters, the urban environment is prone to human induced disasters such as transportation accidents, industrial accidents and major fires. During such calamities, especially disasters, in order to prevent loss of life and property various essential services (like fire brigades, medical and paramedical personnel, police) are deployed. According to the field of Urban Search and Rescue (USAR), the probability of saving a victim is high within the first 48 hours of the rescue operation, after that, the probability becomes nearly zero. Generally, Rescue People cannot enter into some parts / places of the war field or in the earth quake affected areas. All of these tasks are performed mostly by human and trained dogs, often in very dangerous and risky situations. The rescuer may become a victim who needs to be rescued. This is why since some years mobile robots have been proposed to help them and to perform tasks that neither humans dogs nor existing tools can do. For this project, we will focus only on robots which will work in a disaster environment of manmade. The proposed system uses a ultrasonic sensor in order to detect the existence of living humans and a low-cost camera in order to capture video of the scene as needed. Having detected a sign of a living human, the ultrasonic sensor triggers a camera to capture a video of the scene. The simulated robot is assumed to have the capability to determine its current location in real-time, to wirelessly communicate with the rescue team, and to locally store the status and location information about the trapped victims in case the wireless communications link is temporarily disconnected.

Traditionally, equipped robots faced a lot of problems:

i) A very high communication cost was incurred due to the large number of transmitted images to the operator.

ii) More than 25% of the communications between Wireless robot and the control unit was extremely noisy and therefore was useless. This eventually led to a loss of communication between the robots and the operator. As a result, the robots stopped working totally.

iii) A very high processing cost is also incurred by the Capturing, storing, and transmitting a large number of images.

iv) Third, there was a continuous need for illumination due to the dark nature of these environments. This requires a relatively large power supply, which is not feasible in such situations.

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II. Related Work

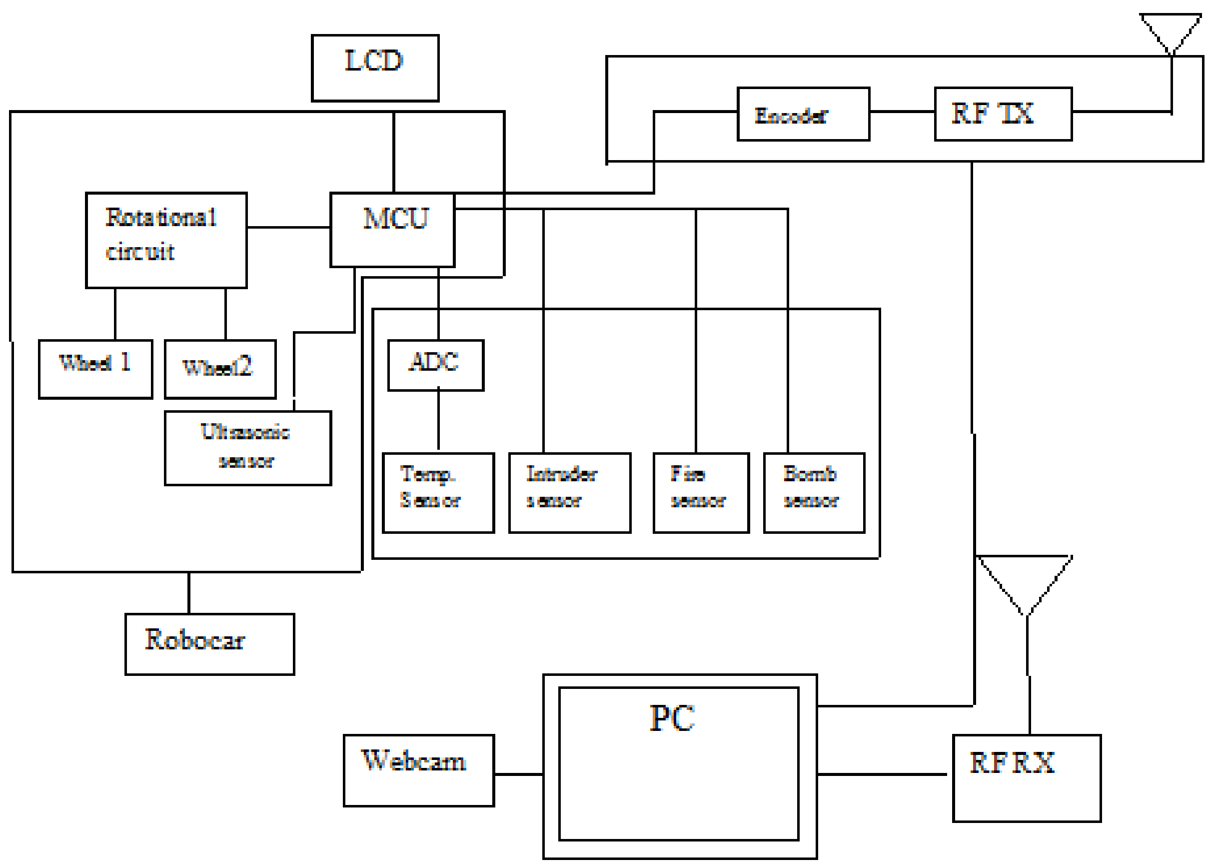
In this section, a brief discussion of some of the related work is presented; focusing on the used approach and its advantages and disadvantages.

Remote Operated and Controlled Hexapod (ROACH): ROACH is a six legged design that provides significant advantages in mobility over wheeled and tracked designs. It is equipped with predefined walking gaits, cameras which transmit live audio and videos of the disaster site, as well as information about locations of objects with respect to the robot's position to the interface on the laptop. Kohga: University of Tokyo - The most complicated task for most of the USAR robots has been working on a rough terrain. Specialized robots have been designed for these types of environments such as KOHGA the snake like robot. The robot is constructed by connecting multiple crawler vehicles serially, resulting in a long and thin structure so that it can enter narrow space.

Quality work has been done in the field of robotics. These robots came into existence in the early 21st century but since then enormous improvements have been made in the concept, design owing to which their capabilities have improved significantly. With limited resources urban search and rescue operations have always been very intricate and dangerous. Most of these tasks are performed by trained rescue personnel and sniffer dogs which are not only risky and time consuming but are not too effective as well. USAR robots aim to address the issues those exist in traditional search and rescue operations. USARs can make their way through debris and even the narrowest of the pathways.

Development of USARs entails numerous challenges– these include, accuracy, negotiating turns, movement in difficult terrains, controlled or no radiations. Size of the rescue robot also plays a crucial role, the bigger the robot the bigger problems it can pose – such as it may cause movement of debris making rescue operations even more intricate. Various rescue robots have been developed and some of these are – CRASAR (Centre for Robot-Assisted Search and Rescue): University of South Florida. This robot was used for first time in real conditions on 11th September 2001 in the World Trade Center disaster. Different sensors like millimeter wave radar for measuring distance, a color CCD camera for vision and a forward-looking infrared camera (FLIR) for the human heat detection are used in it.

III. Block Diagram



Burion presented a project that aims to provide a sensor suite for human detection for the USAR robots. This study evaluated several types of sensors for detecting humans such as pyroelectric sensor, USB camera, microphone, and IR camera. The pyroelectric sensor was used to detect the human body radiation, but its limitation was its binary output. The USB camera was used for motion detection, but its limitation was its sensitivity to changes in light intensity. The microphone was used for long duration and high amplitude sound detection, but it was severely affected by noise. Lastly, the IR camera was used to detect humans by their heat image, but it was affected by other nearby hot objects. The main idea was to detect a change in the image scene by checking the values of the pixels. Several images for the scene were acquired and subtracted from each other to discover if a motion has occurred. The used technique was fairly efficient in detecting the victims. However, the robot was not fully autonomous and was dependent on the operator.
Greer, Kerrow, & Abrantes 2002, represented a thorough understanding of the urban disaster environment and an appreciation for traditional search and rescue techniques are crucial to 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. Much can be learnt from the urban disasters discussed in this paper.

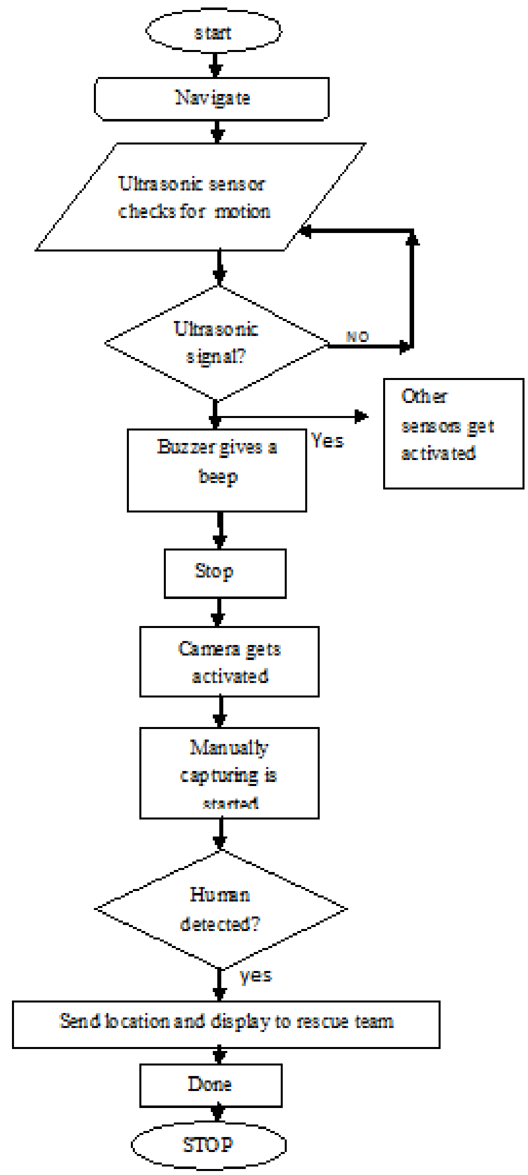
Bahadori presents an analysis of techniques that have been studied in the recent years for human body detection (HBD) via visual information. The focus of this work is on developing image processing routines for autonomous robots operating for detecting victims in rescue environments. The paper both discusses problems arising in human body detection from visual information and describes the methods that are more adequate to be applied in a rescue scenario. Finally, some preliminary experiments for such methods in recognizing rescue victims are reported.

Pissokas describe the social impact of urban devastations has given rise to the field of Urban Search and Rescue Robotics. The aim of this article is to present our experience and experimental results with various sensors designed and developed.

V. Hardware Implementation

In order to simulate the robot, a laptop used T.V Tune Card as well as LCD to display data interfaced wirelessly to the Robot mechanism. A Robot is equipped with following sensors and camera:

i) A Bomb (Metal) sensor to detect the presence of suspected material in Rescue operations.
ii) An ultrasonic sensor to detect human motion and obstacles come in the way of Robot.
iii) A Temperature and fire sensor to measure temperatures and display them on LCD in the form of three states High, Low and Medium.
iv) A camera to record and display data when sensor trigger it.



IV. FLOW CHART OF DEVELOPED SYSTEM

VI. Software Implementation

When the ultrasonic sensor detects a signal, the control program orders the camera to display the surrounding area .If a human is detected, the system sends its current location to the rescue team in addition to the video display if needs be. Figure IV shows the flowchart of the system operation.
The Robot also has a wireless RF Transmitter and sends the message to the Remote Location whenever it finds any alive human.

VII. Applications

i) In military applications to detect the presence of human being.
ii) In Rescue operations where human reach is not possible.
iii) In Medical applications to detect motion.
iv) In Warfield affected areas, to detect the presence of bomb.

VIII. Conclusion

The goal of this research was to 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.

In this paper, a new method for detecting surviving humans in destructed environments using simulated autonomous robot is proposed. 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 an ultrasonic sensor that is used as the primary sensor in order to detect the existence of living humans in a scene. The second level is a human body shape sensor. This level uses low-cost web camera in order to confirm the existence of a human shape. The robot is assumed to be equipped with a simple Temperature and bomb sensor in order to detect fire in Rescue scenario and suspected metal respectively and a wireless communication link in order to communicate with the rescue team whenever a need arises.

IX. Future Scope

Since the system developed is a low cost system therefore it has a wide future scope.

Though many systems with a wide range of sensors have been developed, but there are many problems faced by them such as cost, size, environment difficulties etc.

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XI. References

1. Pissokas, John and Malcolm, Chris (2001) “Experiments with Sensors for Urban Search and Rescue Robots”, Dept. of Computer Science, University of Essex and Division of Informatics, University of Edinburgh, Scotland UK.
2. Greer, Kerrow, & Abrantes(2002) “Urban disaster environments and an approach to search and rescue techniques” .
3. Burion, Steve (2004), Casper, J. (2002), Amerada, Yams, Igarashit, & Matsunos, (2004) and Cappello, C., etal (2005) “Human Detection for Robotic Urban Search and Rescue” Carnegie Mellon University, Institute of Production Robotique (IPR) LSRO2 – VRAI-Group, Microtechnique, February 2004.
4. Cubber, De. Geert. and Marton, Gabor.“ Human Victim Detection” Royal Military Academy Department of Mechanical Engineering (MSTA).
5. Bahadori, Shahram., Iocchi, Luca. “Human Body Detection in the RoboCup Rescue Scenario” Department of informatics, Rome Italy.
6. Binoy Shah and Howie Choset. "Survey on Urban Search and Rescue Robotics," Journal of the Robotics Society of Japan, VOL.22; NO.5; PAGE.582-586, 2004.
7. Kai-Rui Zhao, Xin-Min Wang, Van Li, and Xiang Yu, "A Life-detection System for Special Rescuing Robots," The 9th International Conference on Control, Automation, Robotics and Vision (ICARC), December 2006.