Search and Rescue System for Alive Human Detection by Semi-autonomous Mobile Rescue Robot

Zia Uddin
Dept. of Electronic and Telecommunications Engineering
International Islamic University Chittagong (IIUC)
Chittagong, Bangladesh
(ziauddin.kcpsc@gmail.com)

Mojaharul Islam
Dept. of Electronic and Telecommunications Engineering
International Islamic University Chittagong (IIUC)
Chittagong, Bangladesh
(mojahar.bd@gmail.com)

***Abstract*—** In this modern era, technological development lead the creation of sky scraper buildings and dwellings which increase risks of losing life due to natural and manmade disasters. Many people died by trapping under debris as their presence cannot detect by the rescue team. Sometimes, it is impossible to reach in certain points of the disasters in such calamity hit zones. The situation is worst for developing country like Bangladesh because of low quality design and construction. In this paper, PIR sensor based semi-autonomous mobile rescues robot is developed which can detect live human being from an unreachable point of the disaster area. Joystick and RF technology is used to control the semi-autonomous robot and communicate with control point. Ultrasonic sensor is used for obstacle detection in navigation path of robot and gas sensor is used to detect gas leak inside the building. IP Camera is also integrated to observe and analyze conditions that will facilitate human detection in reliable manner with highest probability of success rate in that kind of situation.

Keywords: Semi-autonomous robot, RF technology, rescue robot, PIR sensor

I. INTRODUCTION

Technology is evolving day by day to make life easy and comfortable. Because of technological development, information about different natural disaster can predict earlier. But man cannot prevent natural disaster from happening. Sometimes they themselves bring disaster to others in the shape of war or bombing or transportation accident or major fire etc. Now a day, Natural disaster like flood, earthquake and cyclone keep happening frequently because people are disrupting the natural balance by cutting trees, destroying hills and unplanned urbanization. During catastrophes, many people lose their life and property. The situation is even worse for developing country like Bangladesh because of their dense population and low quality building and structure. After any disaster, first 48 hours is crucial to rescue defectors. Police, fire service and paramedics are being deployed to minimize the loss of life and property. Sometimes the rescue team cannot reach many parts of disaster affected area due to the inability to search for the live person in the debris. In some situation, they themselves became the victim of the situation. To reduce losses of lives and for getting accurate information of the situation, a robotic system can be used and can be modified according to the needs of the situations.

Quality work has been done in the field of robotics to develop rescue robot. In last decade, different types of rescue robot are made for different type's works and situations. During September 11 disasters rescue robots were first really tested [1]. They were sent into the rubble to look for survivors and bodies. But since 2010, the numbers of incidents that are using robots and using them quickly are rising, with 2011 being a major year with robots at the Christchurch and Tohoku earthquakes. Robots have been used in 35 disasters internationally [2].

There are many types of rescue robots used in this field. Some of them use sensors like ultrasonic sensor [3] or PIR sensor [4] [5] for detecting human in harsh condition and others use different kinds of camera like thermal and IR camera [5] or wide angle camera [6] for wide vision of the debris to find survivors. Some of the robot contain some extra sensors for detecting temperature, fire and bomb [3].

However, the authors try to develop a robot which can detect live human being by using Passive infrared (PIR) sensor and IP Camera. RF and joystick based controller gives smooth control for user. Besides that, ultrasonic sensor is used to avoid obstacles and gas sensor is used for excess gas detection in the affected area. In this paper, we present the system block diagram in Section II. Section III present and describe the system flowchart. Section IV describes about the physical implementation of the system. Finally, conclusion and future improvement are described in Section V.

978-1-5090-6122-8/16/$31.00 ©2016 IEEE

II. SYSTEM BLOCK DIAGRAM

A. Block Diagram

The system is consists of a controller and a semi-autonomous robot. The controller shown in Fig. 1 consists of joystick which is used to drive the robot in controlled way. A potentiometer is also used to control the servo motor attached with the robot. The microcontroller on the controller process data from the joystick and potentiometer and sends the data through Transceiver. Besides that, controller received signal from robot about human detection through RF transceiver which turn on a buzzer connecting with it. LPG or CO level detection is indicated by LED connected with microcontroller output pin. The controller circuit diagram is shown in Fig.2.

Fig.3 shows the block diagram and Fig.4 shows the circuit diagram of semi-autonomous robot. The semi-autonomous robot has PIR and gas sensors to detect human presence and excessive LPG or Carbon Monoxide (CO) in the air of the collapsed building respectively. The robot detects and sends the sensors value to the controller for further processing. The robot is a four wheel control robo-car which can control using joystick command from controller. RF transceivers module is used to receive control data to microcontroller to drive the car. In addition, ultrasonic sensor is used to detect obstacle and for auto navigation if needed. A servo motor is integrated in the robot to drive the camera of the robo-car which is controlled by the analog switch of the controller. Microcontroller receives control data through RF transceiver and drive the servo motor accordingly. An IP camera is also used for observing from a computer terminal and finding survivors of the disaster affected area.

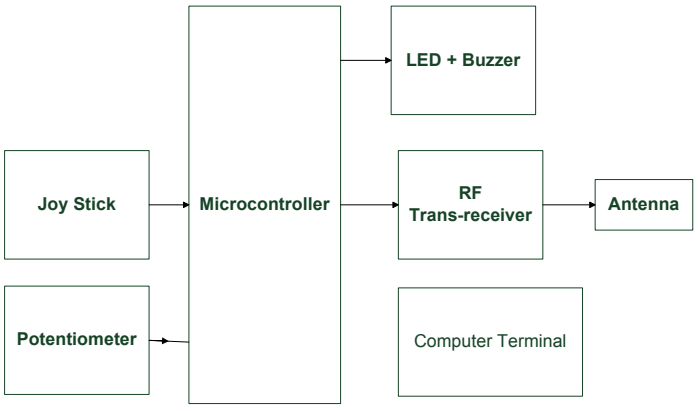

Fig.1: Block diagram of controller of Robot

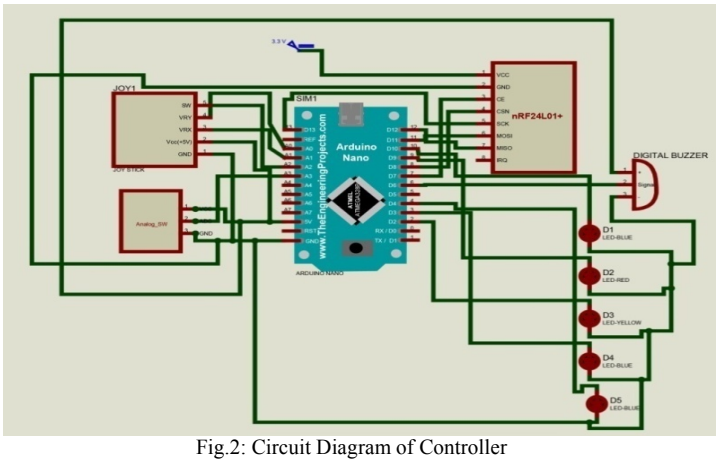

Fig.2: Circuit Diagram of Controller

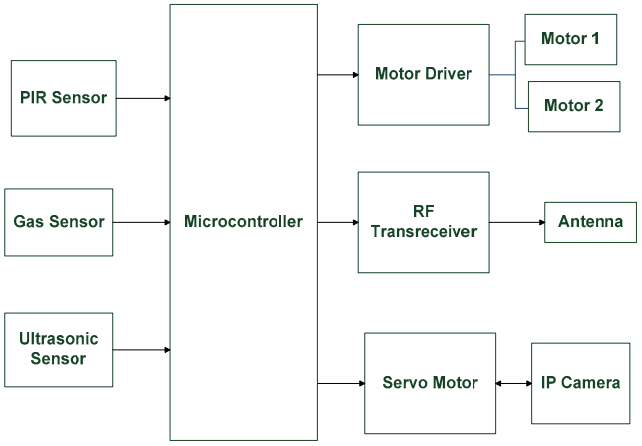

Fig.3: Block diagram of Robot with different sensor

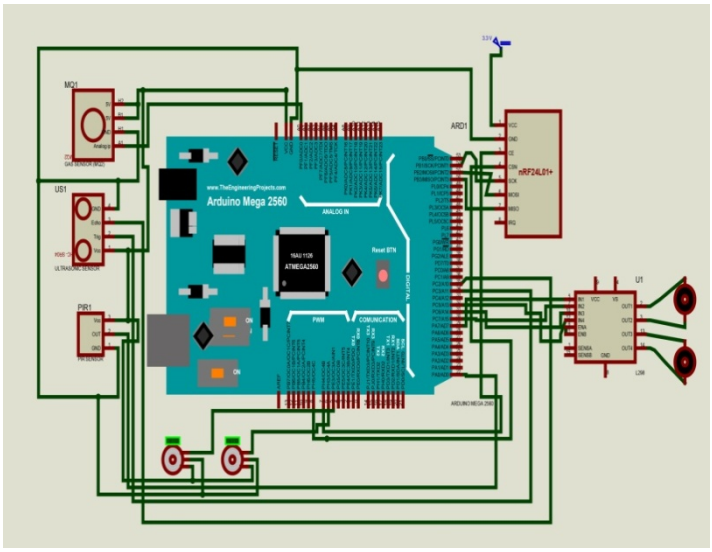

Fig.4: Circuit Diagram of Robot

B. System Operation

Human body radiates infrared waves with wavelengths of 8 to 12 micrometers [2]. When the PIR Sensor detects any signal, it sends the response to the rescue team through the RF transceivers. The IP camera in the Robot is used to observe the situation from a dedicated Computer or mobile terminal to help rescue team to find survivors in the disaster effected area. The IP camera is only turn on after human's presence detection by PIR sensors. It will reduce power consumption of the robotic system. The IP camera video feed can be send via WIFI technology or Cellular data. The IP camera on the robot can be rotated 360^o by a servo for getting 360^o vision of the disaster affected area. The robot is controlled by joystick and RF module attach with the controller. Besides that, ultrasonic sensor is integrated in the robot to detect obstacles on robotic movement. Moreover, the robot has also incorporated gas sensor to detect any major gas leak in the building and it can also detect the carbon monoxide level in the building. The data is send to the rescue team through RF transceivers for different safety measures.

III. SYSTEM FLOWCHART

Fig.5 shows the flow chart of the developed system. First, the robo-car will check for navigation instruction from the controller. The position of the joystick will determine the driving path of the robo-car which will send through RF transreceiver. Depending on the position of joystick, the robo-car can move five different directions "Forward", "Backward", "Right", "Left", "Stop". After that, it will check PIR and gas sensor value. The output of PIR sensor is digital and it will send to controller terminal using RF transreceiver. Human presence will be detected by PIR sensor if the value of the sensor is high. After human presence detection by PIR sensor, IP camera will be checked for confirmation. The location and information about the person will send to the recue team after confirmation of detection. After that, PIR sensor will search again for human presence. In parallel with PIR sensor, Gas level will be detected by gas sensor. The gas sensor is an analog gas sensor. The data of sensors will be transmitted by the transceiver to controller for processing the data. Led will keep blinking if LPG and CO level is higher in the air

IV. HARDWARE IMPLIMENTATION

The robot has two sections one is controller and another is the robot itself. The microcontroller is programmed using programming language C and ARDUINO IDE. ARDUINO IDE has many features which makes it easy to program and compile any arduino based program.

The controller has a microcontroller, a joystick, a buzzer, five LEDs and a RF transceivers module which are aliened according to Fig.2. Fig.6 shows the physical appearance of the controller. Besides that, there is a computer terminal shown in Fig.7 in the controller section to watch the video feed from the robot. The robot has a PIR sensor, an ultrasonic sensor, a gas sensor, four dc motor, a dc motor driver, a RF

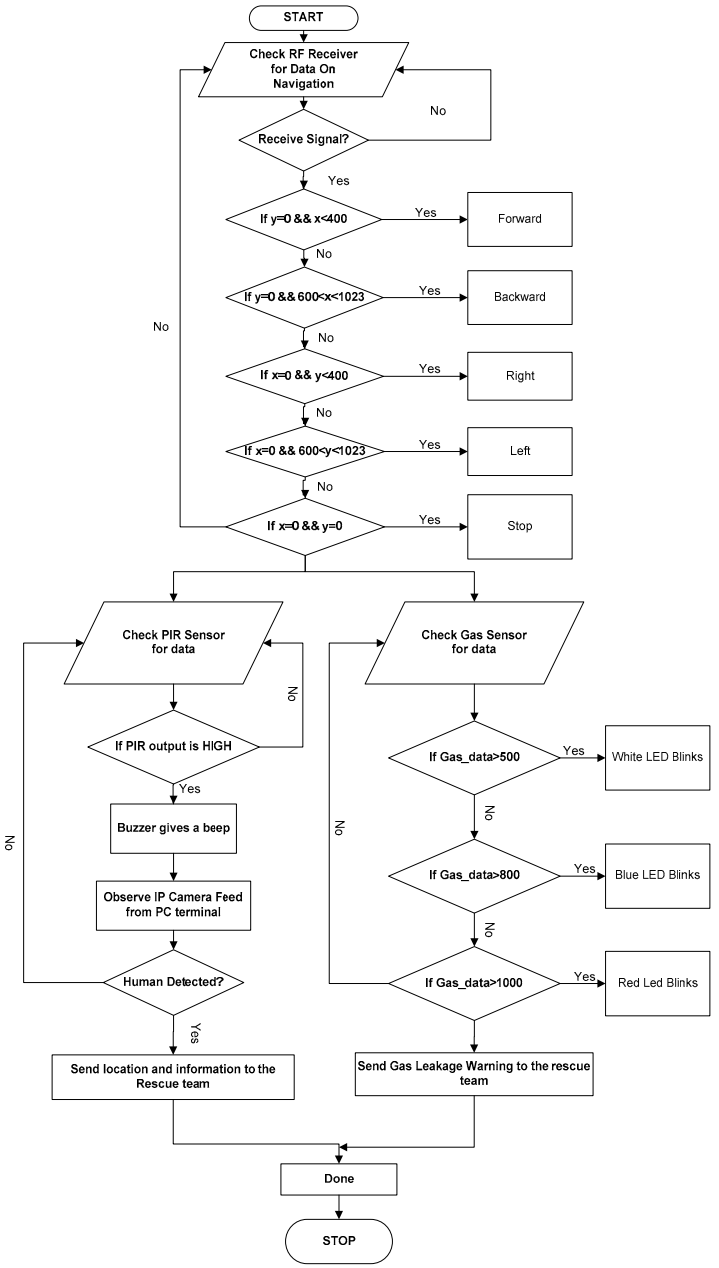

Fig.5: Flowchart of the system

transceiver and an IP camera. The robot is assembled according to the circuit diagram shown in Fig.4. The robot is assembled by adding individual module with the breadboard. All the components except IP camera is interfaced with the microcontroller. The IP camera is attached with a servo motor to

control a movement of 360 degree. Fig.8 shows the physical appearance of the robot.

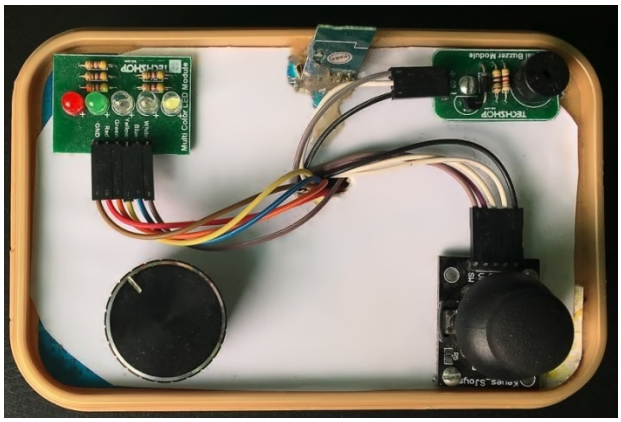

Fig.6: Hardware implementation of Controller of the Robot

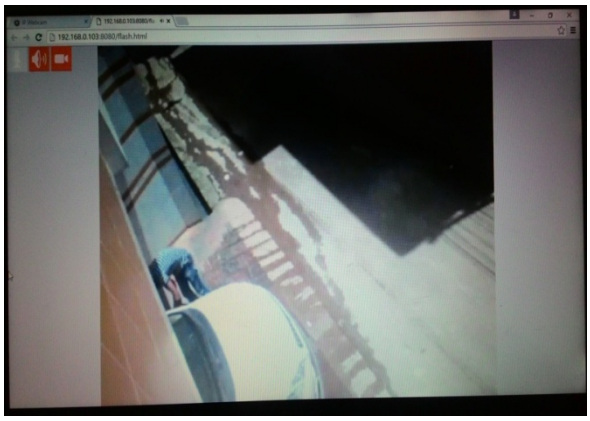

Fig. 7: Computer Terminal for Observing IP camera Video feed

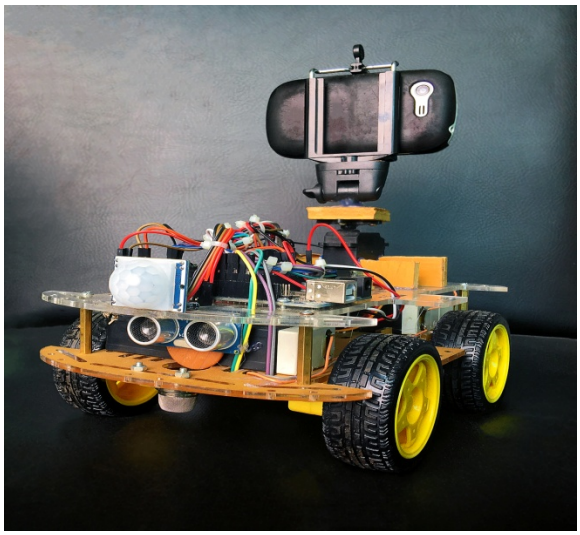

Fig.8: Hardware implementation of Robot

The system is tested for confirming the basic functions and ability of the robot. Those experiments are performed in a realistic training scenario. From Fig.9 and Fig.10, it is clear that the system is well functioning and can easily navigate through narrow path.

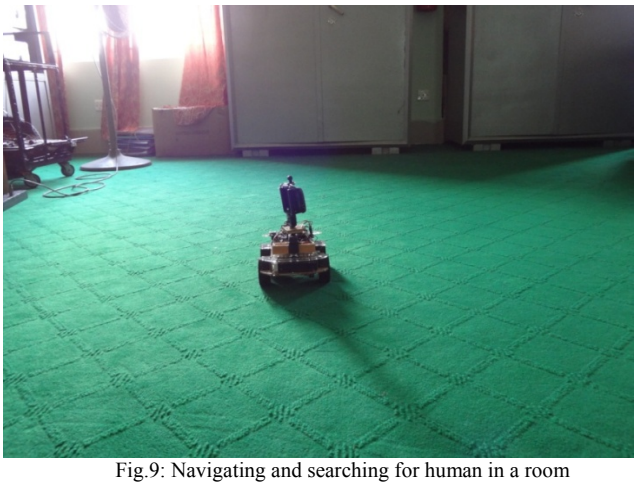

Fig.9: Navigating and searching for human in a room

Fig.10: Navigating through narrow path inside a room

V. CONCLUSION

The goal of this paper is to provide a low cost human detection robot for developing countries rescue mission in extreme situation. The developed robot is joystick control which will facilitate user to drive the system easily. RF module is used for data transfer to make the system reliable inside the disaster area. Though there are many Urban Search and Rescue (USAR) rescue robot available with many sensors and features but they are very costly. The sensors used in this project are cheap and easily available and reliable. The authors developed a system with two level of human sensing in order to reduce power consumption and get higher efficiency in rescue operation. The first level is a PIR sensor which detect human by their radiated infrared wave and second level is an IP camera to confirm the existence of human in disaster affected area. Because of the two levels human detection system the system is reliable for rescue missions.

REFERENCES

[1] http://spectrum.ieee.org/automaton/robotics/industrial-robots/japan-earthquake-robots-help-search-for-survivors

[2] http://crasar.org/2013/09/11/september-11-11-years-after-the-first-use-of-rescue-robots/

[3] S. Bhatia ,Raj Kumar Goel and N. Kumar "Alive human body detection system using an autonomous mobile rescue robot" India Conference (INDICON), December 2011.

[4] Shuddha Chowdhur ,Mahmud Rafiq "A Proposal of User Friendly Alive Human Detection Robot to Tackle Crisis Situation" 12th International Conference on Control, Automation and Systems, Oct. 17-21, 2012 in ICC, Jeju Island, Korea.

[5] 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.

[6] Raymond Sheh and David Mees "Human-System Interaction for Bomb Squad Applications: Preliminary Experiments with Low Cost Cameras in Real World Deployment" IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR),18-20 Oct. 2015.

[7] Carlos Marques, Pedro Lima, Rodrigo Ventura "Semi autonomous robot for rescue operations" Proceedings of the 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems, October 9 - 15, 2006, Beijing, China.