RESEARCH ARTICLE OPEN ACCESS

Rescue Robotic System with a Wireless Sensor Network

Vedansh Thakkar
Medicaps Institute of Technology and Management
Corresponding Author: Vedansh Thakkar

ABSTRACT
The unprecedented number and scales of human-induced disasters and natural calamities has impelled the exigent search and rescue community around different parts of world to seek for newer and more effective equipment to enhance their efficacy. Rescue technology and search till-date rely on old technologies such as camera mounted probes, search dogs, and technology that has been in service since years. For researchers and rescuers, Intelligent robots equipped with advanced sensors are being intriguing. In this paper, a vision based technique is proposed that can be employed in case of hazardous condition where human beings cannot be employed. The main goal is to control a robot which can work spontaneously on an object with a mechanical linkage. By using facial recognition technique, it identifies the intruders. The development of this application uses an 8051 microcontroller which is developed to control the peripheral devices using the sensors such as passive infrared sensor, light dependent resistor and thermostat. From a remote location, a robot is controlled in addition to remote monitoring. The Zigbee technology is used to communicate with the robot in remote location.
Keywords: Wireless Sensor Networks, Robot, Zigbee, Microcontroller.

Date of Submission: 11-10-2017 Date of acceptance: 11-11-2017

I. INTRODUCTION

Humanitarian search and rescue operations can be found in most large-scale emergency operations. Tele-operated robotic search and rescue systems consist of tethered mobile robots that can navigate deep into rubbles to search for victims and to transfer critical on-site data for rescuers to evaluate at a safe spot outside of the disaster affected area has gained the interest of many emergency response institutions. Distributed wireless sensor network applied in many different fields including, medical, civil, and environment research, has demonstrated its value in conveying data over large area with high level of power efficiency, which is particular suitable for tracking the location of search and rescue robots in large search field. This research demonstrates the use of distributed wireless sensor network to track search and rescue robot in an open field. The goal of the research is to develop a physical prototype to demonstrate feasibility of the proposed application that can help to acquire realistic data to use as simulation parameters in future search and rescue research.

The main aim of the paper is to implement a Wireless multipurpose Robot which can be controlled through PC using Zigbee interface and navigates around the disaster areas and tries to find the humans who need help and tries to identify the forest fire. Here the Robot can detect the live human based on the IR radiation emerging from the humans. Apart from this the Robot is built with some artificial intelligence for its safety. It has built in Proximity IR sensor for obstacle avoidance and temperature sensor for forest fire identification. An Embedded System is a special purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few predefined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale.

ARCHITECTURE OF RESCUE ROBOT

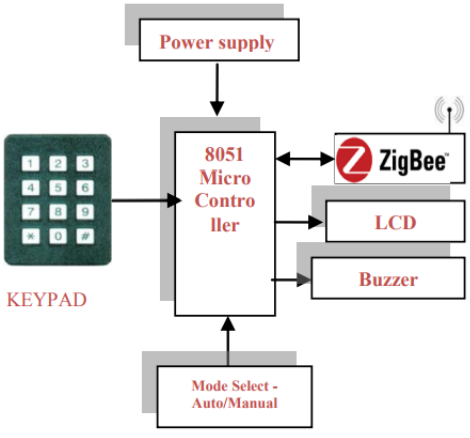

Figure1: Block diagram of control section

A. Microcontroller:

A micro-controller is a low-cost processor. Its main attraction is that on the chip itself, there will be many other components such as memory, serial communication interface, analog-to- digital convertor etc. So, for small applications, a micro-controller is the best choice as the number of external components required will be very less. On the other hand, microprocessors are more powerful, but you need to use many external components with them.

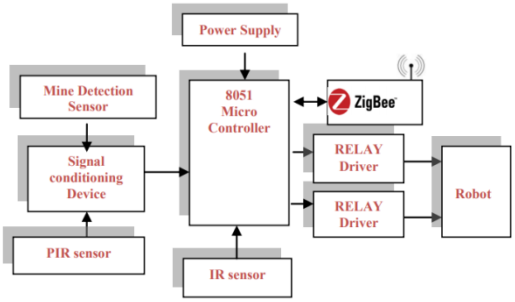

Figure2: Block diagram of robot section

B. Input Devices:

Unlike the desktops, the input devices to an embedded system have very limited capability. There will be no keyboard or a mouse and hence interacting with the embedded system is no easy task. Many embedded systems will have a small keyboard- you press one key to give a specific command.

C. Output Devices:

The output devices of the embedded systems also have very limited capability. Some embedded systems will have a few Light Emitting Diodes (LEDs) to indicate the health status of the system modules, or for visual indication of alarms. A small Liquid Crystal Display (LCD) may also be used to display some important parameters.

D. Communication Interfaces:

The embedded systems may need to, interact with other embedded systems at they may have to transmit data to a desktop. To facilitate this, the embedded systems are provided with one or a few communication interfaces such as RS232,RS422, RS485, Universal Serial Bus (USB), and IEEE 1394, Ethernet etc.

E. Application Specific Circuitry:

Sensors, transducers, special processing and control circuitry may be required for an embedded system depending on the application. This circuit interacts with the processor to carry out the necessary work. The entire hardware has to be given power supply either the 230 volts main supply or through a battery.

F. Zigbee Technology:

In the present days Automated systems have less manual operations, flexibility, reliability and accurate. Zigbee is new wireless technology guided by IEEE 802.15.4 Personal Area Network standard. It is primarily designed for the wide ranging controlling applications and to replace the existing non-standard technologies. It currently operates in 868MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40kbps in USA, and 2.4GHz ISM bands worldwide at a maximum data-rate of 250kbps.

G. Sensors:

A sensor (also called detector) is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an (today mostly electronic) instrument. For example, a mercury-in-glass thermometer converts the measured temperature into expansion and contraction of a liquid which can be read on a calibrated glass tube. A thermocouple converts temperature to an output voltage which can be read by a voltmeter. For accuracy, most sensors are calibrated against known standards. Sensors are used in everyday objects such as touch sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base. There are also innumerable applications for sensors of which most people are never aware. Applications include cars, machines, aerospace, medicine, manufacturing and robotics. A sensor is a device which receives and responds to a signal when touched. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes.

WIRELESS MOBILE ROBOT TRACKING SYSTEM

The low-cost autonomous robotic search and rescue system (Figure 3) presented in was designed to cooperate in large quantity to search for survivors in rubbles. These robots were equipped with wireless communication module to facilitate data and video/audio transfer. These wireless robots, with no tethers, can navigate freely in obstructed environment but are difficult to track their locations once they wander out of the operators' sights. The Zigbee communication module equipped in each of these mobile robots offers an opportunity to track down their locations. The following paragraphs will describe how a Zigbee based sensor network interacts with the onboard Zigbee communication module on each robot to estimate their locations.

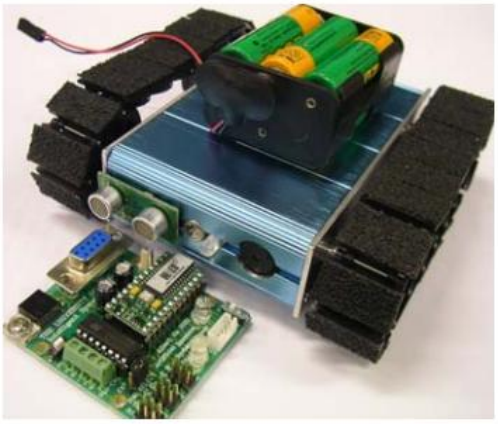

Figure3: The physical prototype of the newly developed robot. The battery pack on top of the robot serves as a scale to show the robots' dimension.

ZigBee (http://www.zigbee.org/en/index.asp) is a wireless technology developed to address the need for a standards-based wireless networking systems for low data-rates, and low-power consumption applications. ZigBee supports many network topologies, including Mesh. Mesh Networking can extend the range of the network through routing, while self healing increases the reliability of the network by re-routing a message in case of a node failure. These unique features are highly desirable for search and rescue robots operating in unstructured environment. The ZigBee-based sensor network hardware employed in this research is based on the Chipcon 2431 (http://www.ti.com/lit/gpn/cc2431) development kit

Figure 4. Zigbee moduleds used in this project. On the left is a stand alone Zigbee module, to the right is a module installed on the development board.

HARDWARE IMPLEMENTATION

Heart of our robot is Atmel's AT89S51. Microcontroller acts as master controller, decodes all the commands received from the transmitter and give commands to slave microcontroller. It also acts as Slave microcontroller which is responsible for executing all the commands received from the master and also generating PWM pulses for the speed control. Based on the input codes master will give command to slave microcontroller and robot will behave as follows.

- moves in forward direction
- moves in reverse direction,
- speed controls in both the direction
- it can even turn left or right while moving forward or in reverse direction.
- Instant reverse or forward running without stopping.

A.Transmitting Unit (control section)

In this circuit 8051 microcontroller is used. It is divided into four ports, port 1, 2 are the general I/O ports for producing the input and output connection between the controller and I/O devices. Keypad is the input device for the controlling section in order to produce the input instruction to the controller. Here, in this mode, the user has the full control of the robot. The user can control the robot from the remote location by using this keypad. Port 2 (from 8-15) which is also an I/O port is interfaced with the LCD for getting the output. The inputs from the microcontroller are fed through the pin 7-14.MAX 232 is used to interface the Zigbee with the microcontroller and it helps to produce the serial communication between them. MAX232 is a dual driver/receiver and typically converts the received/transmitted signals and finally gives the information to the Zigbee. ZIGBEE is the transceiver (transmitter/ receiver). The information from the manual key is given to the microcontroller. The controller processes the received signal and is given to the Zigbee with the help of MAX232 which is transmitted to the robot section.

B. Receiving Unit (robot section)

Three sensors are used to sense the obstacles, bomb, and human beings. The information from the sensor is given to the microcontroller with the help of port 1 and is given to the robot through the same port. The information from the controller is passed to the robot through a relay. Relay is nothing but switch in order to get the information and produce the order to the robot to do specified task.

COMPONENTS OR SUBSYSTEMS DESCRIPTION

A. Microcontroller circuit (AT89c51)

It is the heart of the system which controls all the activities of transmitting and receiving. The IC used isAT89c51.The AT89c51 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density

non-volatile memory technology and is compatible with the industry-standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89c51is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

B. Power supply circuit

The main building block of any electronic system is the power supply to provide required power for their operation. For the microcontroller, keyboard, LCD, RTC, GSM, +5V are required & for driving buzzer +12V is required. The power supply provides regulated output of +5V & non-regulated output of +12V. The three terminals IC7805 meets the requirement of +5v regulated. The secondary voltage from the main transformer is rectified and filtered by capacitor. This unregulated DC voltage is supplied to the input pin of regulator IC. The IC used are fixed regulator with internal short circuit current limiting and thermal shutdown capability.

C. IR sensor

This sensor can be used for most indoor applications where no important ambient light is present. This sensor is used to measure the speed of object moving at a very high speed, like in industry or in tachometers. The basic idea is to send infrared light through IR-LEDs, which is reflected by any object in front of the sensor. The reflected IR light is detected using another IR-LED of the same type.

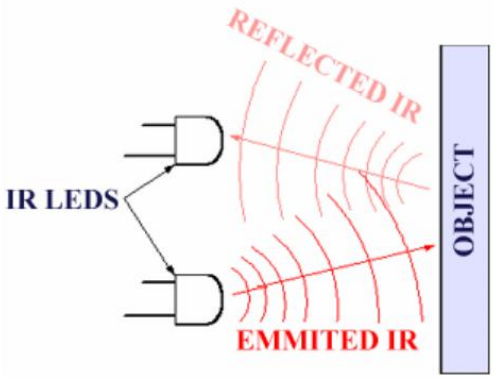

Figure5: IR sensor

D. PIR sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light radiating from objects. They are most often used in PIR- based motion detectors. The individual PIR sensors do not detect motion; rather they detect abrupt changes in temperature at a given point. As an object, such as human, passes in front of the background, such as wall, the temperature at that point will rise from room temperature to body temperature, and then back again. This quick change triggers the detection. Moving objects of identical temperature will not trigger detection.

II. RESULTS AND DISCUSSION

This paper consists of two sections. One is Robot section and the other is Control section. In robot section, the sensors regarding the respective parameters are made to available such as temperature sensor, IR sensor and PIR sensor etc. In the Control section, the parameters are displayed on PC. In Robot and control sections, microcontroller forms the control unit. In this system, a robot is fitted with motors. A microcontroller is used to control all operations. According to the motor operations the ROBOT will operate in specified directions. The detection of parameters is done in a continuous manner and the detected value is transmitted using the Zigbee transceiver to the Control section. Then at the control section, it receives the data with the help of Zigbee transceiver and these data is displayed in the PC and if any live human is detected, the message will be displayed on PC. Robot keeps on moving in two modes i.e., Manual mode and self-mode. It's brought under user's control in the case of manual mode. In self mode, robot starts moving over surface and takes action according to the scenario. To detect the obstacles, we have deployed Infrared sensors (left sensor and right sensor) in the front portion of the module. While moving on the surface, if the left sensor is detected, robot takes back the position for a moment and moves right. If the right sensor is detected, robot gets back and moves left.

III. CONCLUSION

This paper "Rescue Robotics Using Artificial Intelligence" has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of all reasoned out and placed carefully thus contributing to the best working. The controller makes use of a PIR based input sensor to sense the human being and give us an alert indication. Also use of a Temperature sensor leads to identify the fire. Hence this paper provides best solution for the live human detection for who need help and also finds the fire. As we all know, these days India is sick off massive terror attacks, bomb explosions at plush resorts. To avoid such disasters TECHNOLOGICAL power must exceed HUMAN power. Human life and time are priceless. It's our onus to take an initiative to design a model of an apt robot that meets combatant needs. So to avoid terror attacks, to ensure more security at the border and high density areas it's wise to maintain a world class military technology in accordance with combatant needs. Even every nation

needs its own defense system for their integrity and security. In such a way construction of these robots will carry nation's name, fame globally.

APPLICATIONS

1. Can be adequately implemented in national defense through military-industrial partnership. It is shown in the figure.

Figure: View of combat robot

2. Can be vastly applied in Resorts, borders of noted buildings.
3. Installation of combat robots [8] in the stadiums, sacred places, and government and non-government organizations assures top security.

REFERENCES

[1]. Patrick Lina,*,1 Keith Abneybb,c,2 George Bekey a,3"Robot ethics: Mapping the issues for a mechanized world" a .California Polytechnic State University, Philosophy Department, 1 Grand Avenue, San Luis Obispo, CA 93407, USA. b. California Polytechnic State University, College of Engineering, 1 Grand Avenue, San Luis Obispo, CA 93407, USA. c.University of Southern California, Viterbi School of Engineering, Los Angeles, CA 90089- 0781, USA.

[2]. George Bekey," Autonomous Robots: From Biological Inspiration to Implementation and Control", MIT Press, Cambridge, MA, 2005.

[3]. Mr. M. Arun Kumar, Mrs. M. Sharmila "Wireless Multi Axis ROBOT for Multi-Purpose Operations", Department of ECE, SVCET & JNT University Anantapur, India.

[4]. Dr. S. Bhargavi, S. Manjunath, "Design of an Intelligent Combat Robot for war fields", Department of Electronics and Communication Engineering, S.J.C.I.T, Chikballapur, Karnataka, India

[5]. www.Atmel.com

[6]. Atmel data sheets http://www.keil.com/dd/docs/datashts/atmel/at89s51_ds.pdf.

[7]. Robert L.Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 8th Edition, 2006.

[8]. Pete Miles & Tom Carroll, Build Your Own Combat Robot, (2002).

[9]. Werner-Allen, G., Lorincz, K., and Welsh, M. (2006) "Deploying a Wireless Sensor Network on an Active Volcano," IEEE Internet Computing, March issue, pp.18-25.

[10]. Zubair, L. (2004, December 28th). Scientific Background on the Indian Ocean Earthquake and Tsunami. Retrieved June 27, 2006, from The International research Institute for Climate and Society: http://www.library.cornell.edu/newhelp/res_strategy/citing/apa.html#ap

[11]. Paek, J., Chintalapudi, K., Govindan, R., Caffrey, J., and Masri, S.(2005) "A Wireless Sensor Network for Structural Health Monitoring: Performance and Experience," Proc. 2nd IEEE Workshop on Embedded Networked Sensors, IEEE CS Press, 2005; www.cse.unsw.edu.au/~emnet.

[12]. Patel, S., Lorincz, K., Hughes, R., Huggins, N., Growdon, J.H., Welsh, M., and Bonato, P. (2007) "Analysis of Feature Space for Monitoring Persons with Parkinson's Disease With Application to a Wireless Wearable Sensor System," In Proceedings of the 29th IEEE EMBS Annual International Conference, Lyon, France, August 2007. www.eecs.harvard.edu/~mdw/papers/parkinsons-embs07.pdf

[13]. Snyder, R. (2001). "Robots assist in search and rescue efforts at WTC," IEEE Robot. Automation Magazine, vol. 8, pp. 26-28.

International Journal of Engineering Research and Applications (IJERA) is **UGC approved** Journal with Sl. No. 4525, Journal no. 47088. Indexed in Cross Ref, Index Copernicus (ICV 80.82), NASA, Ads, Researcher Id Thomson Reuters, DOAJ.

Vedansh Thakkar. "Rescue Robotic System with a Wireless Sensor Network." International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 11, 2017, pp. 51–55.