Remote monitoring and control systems in hazardous area

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Abstract: Pyroelectric Infrared sensors (PIR) sensors are excellent devices for wireless detection of victims in disastrous areas like earthquake, landslides and being low-cost, low-power are widely. A new approach of detecting alive humans in destructed environments using a robot, equipped with a smart phone and PIR sensor is proposed in this paper. Since some years mobile robots have been proposed to help the rescue squad to perform tasks that neither humans dogs nor existing tools can do. In this project, we will focus on robot equipped with PIR sensor for motion detection of victims and sending the information to sever side to act accordingly and rescue the people who are alive and struggling for life.

KEYWORDS: PIR sensor, human detection, wireless sensor

I INTRODUCTION

Earthquakes, landslides, cyclones, floods are some of the natural disasters that time and again make us realize that there is no power bigger than that of the Nature around us .With the evolution of science and technology at an uncontrolled pace, and the creation of sky scraper buildings and dwellings and encroachments everywhere, the risks of losing life due to such calamities has all the more increased and added to the chaos. Moreover, with the advancement in nuclear technology, the risks of manmade calamities like nuclear explosions and nuclear radiation leaks have also reached an all-time high. Many people get killed instantly due to these natural and manmade disasters when they hit a region. Many others get trapped under debris for hours and days because their presence there cannot be detected by the rescue teams easily. Hence, they die a painful death as help could not reach them on time. The rescue team workers cannot enter certain parts in such calamity hit zones. For these reasons and others, for past some years mobile robots are being introduced for such rescue purposes. [1][2].

The project focuses on rescue of human beings who are alive and struggling for their lives either in the war field or due to natural disasters like earthquakes, to be recognized and rescued in a much faster pace. The robot senses humans alive using a PIR sensor and sends a notification to the mobile to capture the images of the same. The captured image is then sent to the server to view and act accordingly. The administrator at the server end has options to move the robot in any required direction for more accurate detection of human beings alive.[2][4]

II BLOCK DIAGRAM OF PROPOSED SYSTEM

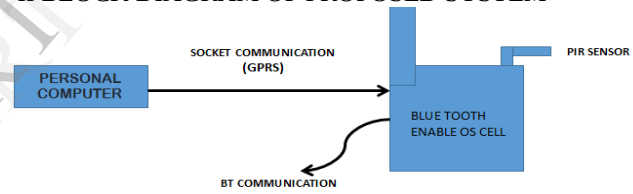

FIG 1: BLOCK DIAGRAM OF REMOTE MONITORING AND CONTROL SYSTEMS IN HAZARDOUS AREA

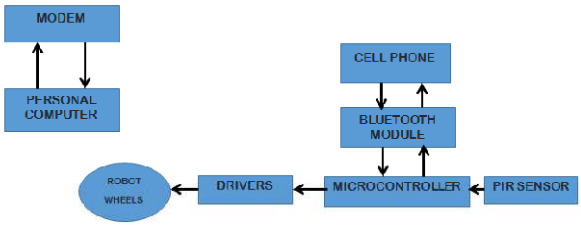

FIG 2: DETAILED BLOCK DIAGRAM

2.1. Server-Side

The server PC is designed to monitor the place by viewing the video being streamed from the mobile. The server has the privilege to move the robot remotely i.e. Left, right, front and back to have the person in focus. The PIR could also be controlled by turning it on/off.

2.2. client-side

At the client end, the symbian c++ is responsible for the communication between the robot and the mobile through Bluetooth. There is an option for controlling the PIR sensor i.e. to turn on/off. The PIR sensor senses for any motion in the affected area and when the motion is detected, the PC is intimated by the mobile through socket communication as well as starts capturing the images.

III DESIGN AND IMPLEMENTATION

The PIC16F877A microcontroller is the heart of this proposed design. It is a 40 pin, 8 bit CMOS flash microcontroller. It has 5 input/output ports A, B, C, D, and E. It has a built-in 10 bit ADC. [2]

The Bluetooth receiver is connected to port C of PIC16F877A. Pin C6 is used for transmission, while C7 is used for reception. The robot is mounted with a smart phone with Symbian operating system and is Bluetooth enabled. The robot and mobile communicate with each other through Bluetooth. The server i.e. PC and the client i.e. mobile communicate with each other through socket communication (GPRS). The commands sent by server are communicated to robot through mobile. Thus we can operate the robot remotely in the actual location.

The Passive Infrared Sensor (PIR) sensor which is used for motion detection is connected to port B of PIC16F877A.These are electronic devices that measure IR light radiating in its FOV. Apparent motion is detected when an IR source of one temperature such as human passes in front of IR source of another temperature such as wall. Whenever motion is detected from any alive human being, this signal is sent to server by mobile through socket communication as well as it starts capturing images. The mobile streams the video to server such that status of alive person can be known. The robot can moves front, back, left and right to monitor the place more accurately and get clearer images of person to be rescued. [3]

A ULN2003 driver IC is connected to port C of PIC16F877A. It is a high voltage, high current Darlington driver IC. The output current of Microcontroller is 25mA, which is not sufficient to drive the relay. Hence ULN2003, a relay driver is used to drive relay in turn control the device. It consists of seven NPN Darlington pairs, each outputs maximum of 500mA.

ULN2003 is used to drive four relays. All the 4 relays used are electromechanical relays. The excitation voltage required is 12V dc. The relay gets activated on application of 12vdc and in process turns on the DC motor. When excitation voltage is stopped, relay is deactivated and turns OFF the DC motor. Two relays are used for each of the two DC motor. [3]

Another ULN2003 is used to drive APR9600 IC. The APR9600 device offers true single- chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. The device supports both random and sequential access of multiple messages. It is connected to port E of PIC16F877A microcontroller.

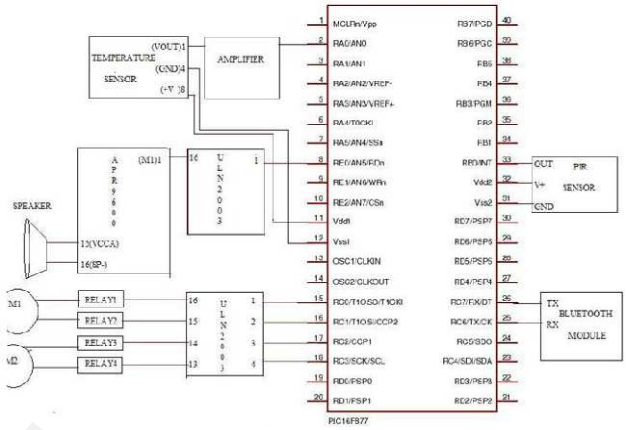

FIG 3: CIRCUIT DIAGRAM

IV FLOWCHART OF SYSTEM

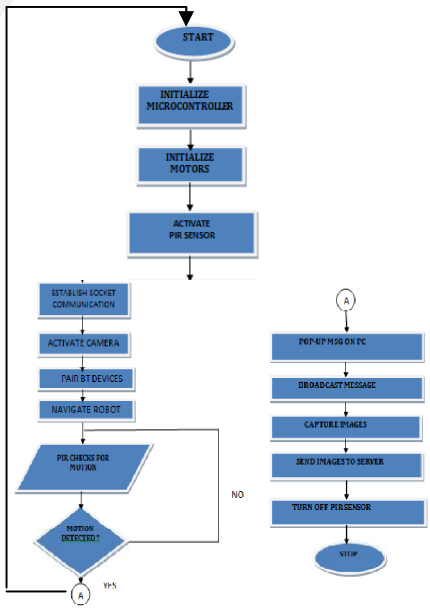

FIG 4: DIAGRAM

The PIC16F877A microcontroller is initialized. We have used two DC motors to move the robot in required direction. The robot is made to navigate in the actual location. The motion sensor

that is PIR sensor is turned ON to detect the motion of alive human being. We have used Socket communication (GPRS) to establish communication between server (PC) and client (mobile). [4]The camera of the smart phone (Nokia N72) placed on the robot is activated and also it is Bluetooth enabled. The robot is moved in all directions to check for motion of human beings. If motion is detected then PIR sensor sends signal to microcontroller which in turn broadcasts the message "Rescue team has arrived". A popup message is also displayed on computer. The camera then captures the images of the victim and sends them to the server side to be viewed by the administrator to take necessary steps to rescue the victim. If motion is not detected then robot is navigated in other directions to search victims. There is also facility to turn OFF the PIR sensor.

V SOFTWARE IMPLEMENTATION

The software tools used for implementation are: Java, J2ME and Symbian C++ programming languages. The server system is built using the Java programming language. For client programming I have used Symbian C++ and J2ME programming languages. For communication between the server and client Socket programming is used.

5.1. Java programming language: Java programming language is used since it is simple, portable, object oriented, compiled and interpreted, distributed, high performance, robust, multithreaded, secure, dynamic and architecture neutral. From these buzz words one can realize why Java is such a powerful language. A form is created on server PC through which the robot can be controlled remotely.[4]

5.2. Symbian OS: Symbian is an operating system dedicated to mobile phones. It is different from windows. It takes small space for installation. Symbian is an operating system (OS) targeted at mobile phones that offers a high-level integration with communication and personal information management (PIM) functionality. Symbian OS offers a choice of programming languages to the developer. Symbian OS is written in C++ and this is therefore regarded as its primary programming language. The other programing languages which you can use on Symbian: JavaScript, Assembler, WMLScript, C, C#, Visual Basic and OPL.

5.3. J2ME programming language: J2ME is the Java platform for small devices. It is a subset of J2SE (Java 2 Standard Edition). Almost every mobile phone support J2ME. Among all the current technology, because of its modular approach to targeting small devices, Java ME (J2ME) has positioned itself as the best solution for an extremely wide range of small devices.

5.4. Bluetooth: Bluetooth is used to for communicatiojn between the client (Mobile phone) and the server (PC). Bluetooth, the short range radio technology standard, is among the latest trends in wireless communications. Bluetooth range varies from 10m to 100m depending on the power of the transmitter at the antenna. The power consumption of the radio unit is extremely low ranging from 1mWatt to 100mWatt depending on the required operation mode. Bluetooth aims at unifying various short-range wireless technologies. Bluetooth enjoys superior features when compared to other Wi- Fi (Wireless Fidelity) such as greater security, convenience, interoperability, reliability, speed and power.

5.5. Socket Programming: A socket is one endpoint of a two-way communication link between two programs running on the network. To put it differently, it is through sockets that applications access the network and transmit data. Like all other functionalities provided by Java, functionalities to work with sockets are also "packaged" as a package and its classes. The following are the package and its main classes that help in accessing sockets:

1. Java.net package
2. Server Socket
3. Socket

The java.net package contains all the classes required to create network enabled applications. Server Socket and Socket are also part of this package. Apart from these classes, it also contains classes to connect to the web server, create secured sockets, and so forth.

The Server Socket class provides server sockets or sockets at server side. Such sockets wait for requests over the network. Once such requests arrive, a server socket performs operations based on the request and may return a result. The Server Socket class wraps most of the options required to create server- side sockets. The Socket class provides client- side sockets or simply sockets. They are at the client side connecting to the server, sending the request to the server and accepting the returned result.

VI RESULTS AND DISCUSSION

6.1. Detection range of PIR sensor

The figure below shows the range of motion detector can detect a movement. I tested the sensor and it can detect a motion on the side for the angle of 70° of

each side. Besides that, the range that directly in front of the sensor can reach up to 4 meters.

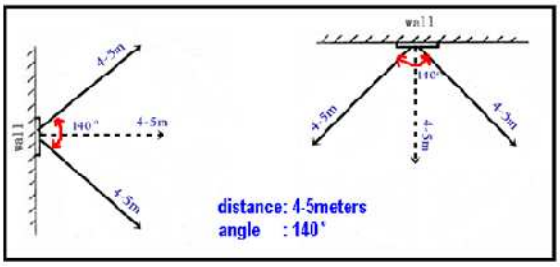

FIG 5: DETECTION OF PIR SENSOR

6.2. OUTPUT VOLTAGE FOR SEVERAL RANGES DISTANCE*:* For certain range of detection, the experiments have been done for several distances which are from 0.5 meter to 5 meter. The value of output voltage is not changed over the distance.

Distance (m)	Output voltage (V)
0.5	3.346
1.0	3.345
2.0	3.345
3.0	3.346
4.0	3.345
5.0	3.346

TABLE1. OUTPUT VOLTAGE OF PIR SENSOR

6.3. Evaluation of LM35:

Two readings are recorded, one is water's temperature measured by the Multimeters and other is LM35's output voltage.

Multimetre reading (temperature in °C)	LM35 output voltage (in mA)
10	0.11
15	0.15
20	0.21
25	0.24
30	0.31
35	0.35
40	0.40
45	0.47
50	0.49

TABLE 2: MULTIMETER READING AND OUTPUT VOLTAGE OF LM35

The temperature is calculated using the equation:
Temperature (**o**C) = Vout * (100 **o**C/V) For example: Vout = 0.11
Temperature = 0.11*100= 11◦C

In conclusion, LM35 is accurate enough to rapidly use as temperature sensor. The voltage is directly indicating the temperature. The Temperature reading may have 1-3◦ C error.

VII CONCLUSION

The goal of this project was to provide a low cost robot for human detection in Warfield and earthquake affected areas. The integration of the sensors on the robot and their evaluation to detect victims was the second part of the project. The Pyroelectric sensor used for motion detection is satisfactory. The robot modeled will be useful in human detection and will assist the rescue squad very effectively and efficiently.

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