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A new approach for detecting alive human beings in devastating environments using a low cost autonomous robot

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Abstract - The paper proposes advanced approach for detecting alive human beings in devastating environments using a low cost robot. In The proposed approach alive human body detection system using a set of sensors that gives information about the presence of an alive human body and a low quality camera to get a video of scene of the environment. Having detected a drawback or alive human body, the set of sensors trigger the camera to show live scene. The video is then displayed on a PC or a laptop at base station and processed at MATLAB for further analysis. The living human detection system proposed in this paper is highly reliable as it is using a set of sensors for detection. By this approach the information gathered and processed for difficult situation with low coast.

Index Terms- autonomous robot, Passive Infrared (PIR) sensor, Infrared (IR) sensor, relays and motors

1. INTRODUCTION

Autonomous robotic system is a great innovation of a modern technology. It has been able to provide significant support to mankind by accomplishing arduous tasks that are apparently infeasible for human beings to perform.

The proposed embedded robotic system detects alive human body in the catastrophic environments which is very helpful for rescue operations. Disasters can be of two kinds- natural and human-induced. Natural disasters are not under the control of human beings. They include earthquakes, floods, storms, cyclone, fire etc. Besides natural disasters, an urban area is very susceptible human-induced disasters. They include industrial accidents, transportation accident, accidents during mining, warfare etc. Whatever may be the reason, during such calamities, various services are deployed for rescue operations. In order to increase the probability of saving lives of the victim, the rescue operation needs to be faster. But, sometimes, it is difficult for rescue personnel to enter into some parts/areas of the Warfield or earthquake affected areas. In such circumstances, mobile robots have been proposed to be deployed to help them and to perform tasks that can be performed neither by rescue team nor by existing tools and techniques since some years. This paper proposes a mobile robotic system which will work in disastrous conditions. The proposed system uses PIR sensor to detect the motion of human body and IR sensor to detect any obstacle on the way of robot. Having detected the sign of living humans, thesystem sounds buzzer and the sensors trigger a camera mounted on it. The camera captures a video scene of the environment and gives information about the status and location of trapped human lives.

The existing system suffered many problems like high cost to set up communication between robot and rescue control unit, noisy wireless communication link between robot and control unit which ultimately stopped robot to function etc. The proposed system is able to solve all these problems.

II. SENSORS USED

The proposed system uses various sensors to detect alive human reliably. The sensors are placed in the robot moving in all the directions to convert the physical quantities like radiations from the body, temperature etc which are the basis for alive human detection into the signals that are easily read or interpreted by remote observer or rescue team. Different types of sensors used in the proposed system are:

a. PIR Sensor

It is passive infrared sensor which detects the motion with the variation of infrared radiation. It consists of multiple facets with each part containing Fresnel lens. Fresnel lens condenses light providing a large range of IR to the sensor. It provides single bit digital output and is compatible with all microcontrollers. The motion of injured person can be detected with this sensor.

b. IR Sensor

It consists of two sections-transmitter and receiver. Transmitter continuously sends the IR signal and receiver receives the reflected light from the obstacle. So, it has been used as the obstacle detector in the proposed system. To get precise output,

LM339 comparator has been used. Whenever receiver receives reflected IR signal LED glows indicating obstacle is detected on its path.

III. BLOCK DIAGRAM

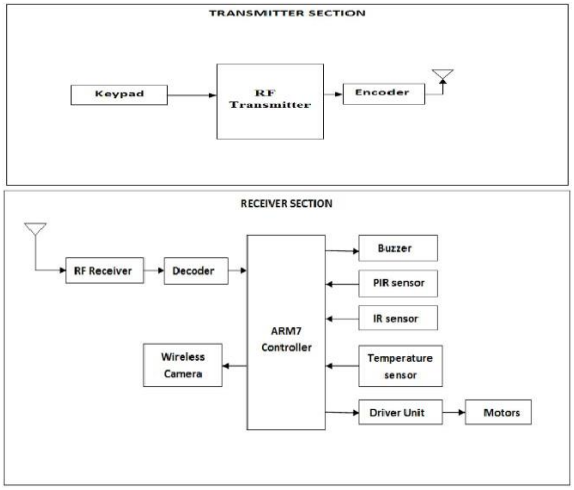

Figure 1:Block diagram of proposed system

A. RF transmitter and Encoder

HT12E (18 pin DIP) CMOS LSI encoder is used for remote control of the robot. Encoder is capable of encoding 12 bits of information (4 data bits & 8 address bits). 4 data bits are derived from four buttons provided to control forward, backward, right
and left control of the robot. High noise in mainly easy interface and low standby current are some of its features. It's operating voltage is 2.4-12 V. It has also got built-in oscillator. A wired antenna is used for transmission of encoded signals serially. RF frequency used for transmission is 433.92 MHz.

B. RF receiver and Decoder

HT12D (18 pin DIP) CMOS LSI decoder is used for receiving controlling signals from the transmitter. It decodes 4 bits of data sent by encoder and output is given to the controller. It is capable to decode 12 bits of data. The received bits are checked 3 times. Its operating voltage is 2.4-12 V. A wired antenna is used to receive the encoded signal serially. It is compatible with HT12E.

C. ARM Controller

LPC2148 ARM7 TDMI has been used as a controller in the proposed system. It is used to process all the signals in the system. The features of ARM controller are:

a. It has 32-bit RISC architecture with 64 multifunctional pins.
b. It has 2 ports; port 0 having 32 pins and port 1 having 16 pins.
c. It supports 32- bit ARM instructions as well as 16-bit thumb instructions. Thumb instructions support on-chip debugger, hardware multiplier and in-circuit emulator which are the most distinguishing features of LPC2148.
d. It has 40 KB static RAM and 512 KB on-chip flash memory.
e. It uses 50 MHz crystal oscillator as the source of clock.

Some other features like low power consumption, small amount of Silicon die area, easy availability of open source development tools, high performance with small gate count etc make it most suitable for this system.

D. Relays and Motors

4 relays are used to run 2 motors in the proposed system. Relays are electromagnetic switches which are used switch between different voltages. In this system, relays are used to obtain 12V output which is necessary to run motors from available 3.3V output from ARM controller. Two 60rpm dc motors are used to run the robot. The different sequences of output from relays run the motor in different directions.
The user gives input from the transmitter section by pressing the keypad and the controlling signal is passed to receiver section

from the transmitting antenna. The receiver antenna receives and decodes the signal and it is processed by the microcontroller to run the robot. The sensors sense the obstacles or human that come on the way of robot and corresponding outputs from the sensors are processed by the microcontroller and robot stops at the moment. The buzzer makes a sound to alert rescue team whereas wireless camera turns on to capture the scene. The whole system is powered by Li-ion batteries of 12V
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The software components used are:

a. Embedded C- for interface programming.

b. Flash Magic- for choosing the way a specific device connects to PC and selecting the COM port to be used and the baud rate.
c. Kiel- for controller programming.
d. MATLAB- for image processing.

IV. WORKING PRINCIPLE

The robot is manually controlled by the keys provided in the transmitter section using RF technology. Mobile robot is sent to the field and it is controlled from base station. Base station consists of PC communicated with robot via wireless camera with high band RF communication.
Robot is provided with three sensors. Based on the signals from the sensors, the movement is controlled automatically. An IR sensor basically detects the obstacles on the path of the robot. PIR sensor is used as motion detector in the proposed system. Based on the variation of infrared radiation, PIR sensor detects the motion. Temperature sensor can be used for fire detection in the rescue operation. Whenever the signal comes from any of the sensors, the motion of the robot is ceased and at that instant, the wireless camera starts working. The base station PC starts getting video footages through wireless camera and further action is taken accordingly. This will help to detect human beings from other natural objects and animals.

V. RESULTS AND DISCUSSION

To test the functioning of the robot, it was equipped with sensors and a low quality camera. The keypad provided in the transmitter was pressed to navigate the robot in all directions. Many obstacles were placed along its path. When the robot confronted the obstacle, IR sensor sensed the obstacle. The robot automatically stopped. To test the working of PIR sensor in the proposed system, human motion was introduced in its path. On sensing the motion, the robot stopped. When heated iron rod was placed in the vicinity of the moving robot, the robot automatically stopped. The temperature sensor is activated when the temperature exceeds the calibrated temperature.

Figure 2: The Prototype of the proposed system

Whenever the robot stopped automatically, the buzzer made a sound and wireless camera was turned on. The wireless camera was communicated with PC by using high band RF communication module. Later on, the video footage was processed in PC by using image processing tools available in MATLAB.

VI. CONCLUSION AND FUTURE SCOPE

The purpose of the proposed system is to provide a cost effective robot for rescuing human beings in catastrophic conditions. The proposed system is superior to other existing robots due to the use of sensors that are cheaper and easily available. It is not feasible for rescue personnel to individually visit the site (war field, earthquake-stricken area, mines etc) and check who is alive and who needs rescue. So, in such circumstances, the proposed system can be of great importance. It can be deployed to detect alive human beings and send the information regarding the situation of the spot to rescue team for proceeding further rescue operation. Furthermore, the reliability of detection is enhanced by two level sensors. The first level sensor is PIR sensor which detects the motion of human. This is primary sensor. The second level sensor used is IR sensor. It is used to detect the obstacle that comes on the way of robot. So if one sensor fails, other sensor can also provide sufficient information in conjunction with the wireless camera mounted on it.

This prototype can be further enhanced in the future by incorporating an IR camera that can exactly capture IR pattern emitted by human body. In addition, to know the exact location, GPS system can be added. For increasing the range of communication with the rescue team, GSM module can be included. Furthermore, metal and bomb detector can be used to protect from possible damage.

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