International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-4, Special Issue-6, Aug 2016 E-ISSN: 2347-2693

Live Human Detection for Robotics in Urban Search and Rescue

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Available online at: www.ijcseonline.org

Received: Jun/26/2016 Revised: July/08/2016 Accepted: July/29/2016 Published: Aug/12/2016

***Abstract*—** In this modern world of globalization, high speed technology and automation we can make robots which are faster, more efficient as well as intelligent according to our own work requirements with the help of proper knowledge on advance robotics and with the use of proper equipments. Each and every year in various parts of the world, due to natural calamity (e.g. earthquakes, landslides etc) or by any other sudden disaster which happens without any warning (e.g. sudden collapse of manmade structures such as bridges and high rise buildings, etc), many humans gets stuck and remains buried underneath various materials. It becomes impossible to detect them through conventional search and rescue operations (e.g. sniffer dogs) among the debris and are not rescued. These humans die eventually from suffocation or infection occurring in heavily injured body parts. But with the use of "Live Human Detection for Robotics in Urban Search and Rescue" we can still save maximum of them within a very short interval of time.

***Keywords*—** Cell Phone Operated Land Rover, PIR Sensor, A/V Camera, Solar Panel.

I. INTRODUCTION

In this project we have used a Cell Phone Operated Land Rover on which PIR sensors, A/V Camera along with other electronic components are mounted on top. In a disaster environment, the robot's PIR sensor [9] detects thermal radiations which are emitted from living human bodies [11] and accordingly an alarm is sounded so that the operator can understand the presence of a live human being and that help can reach to that person as immediate as possible. The operator can also see the situation in and around the disaster environment and also the situation and condition the persons trapped underneath through a camera which transmits live audio and video directly from the disaster sites, as well as information about the locations of objects with respect to the robot's position to the interface on a laptop or television screen. The compact size of the robot helps it to enter and leave through small openings. This robot is driven by DC motors which can perform forward and reverse movements and has a very small turning radius, so it is very easily movable through tough and ragged places. Detection by search and rescue workers is very much time consuming so to reduce precious time consumption and to get the work done more efficiently and quickly, we are using robots for search and rescue operations in any form of natural disaster environment [8].

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II. CELL PHONE OPERATED LAND ROVER

The circuit of the cell phone operated land rover is being powered by the 6V battery which is mounted on the land rover itself. This land rover has an infinite range as it works in GSM mode. To move the robot, the operator make a call to the cell phone attached to the robot by a head phone from any other phone; on pressing the numeric buttons DTMF tunes [1] are sent. The cell phone on the robot is previously kept in 'auto answer' mode. So after a ring, the cell phone on the robot automatically accepts the call. Now the operator can operate the land rover by simply pressing the button on his mobile phone to perform the movements as listed in the table given below. The DTMF tones which are produced are being received by the cell phone placed on the land rover itself. These tones are fed to the circuit through a headset which is being connected to the cell phone on the land rover. The IC MT8870 decodes the received tone and sends the binary number to the microcontroller [13], but before that the binary numbers are passed through a buffer or a NOT Gate to get the reverse equivalent binary number which were initially got from the output of the IC MT8870 Decoder which acts as input for the microcontroller IC ATMEGA16. According to the C program which is already burned in the memory of the microcontroller IC ATMEGA16 according to which the rover will start to move, but the DC motors [7] have particular polarity and direction of rotation which depends on direction of the current flow. So a DC motor cannot be interfaced directly with the microcontroller because it requires a very high

voltage and current to operate [10]. Therefore, a motor drive is used. Here IC L293D [1],[4] motor driver is used to drive the rover [9]. IC L293D is connected to the motors of the land rover. One IC L293D can handle two motors at a time so if four motors are being put on the rover, therefore two IC L293D motor drivers should be used. As this driver gets connected to motors which require very high power to run so they act as an interfacing device to supply required power to the motors.

A. Algorithm

- Step 1: Start
- Step 2: Declare variable
- Step 3: Set port A as input port
- Step 4: Accept input

  If i/p is 0x02 then move motor in forward direction

  If i/p is 0x08 then move motor in backward direction

  If i/p is 0x04 then move motor left

  If i/p is 0x06 then move motor right

  If i/p is 0x05 then stop moving motor

- Step 5: Stop

Hence we see that when "2" is pressed on the calling cell phone the rover starts to move forward, when "8" is pressed the rover starts to move backward. "4" and "6" are the directional keys pressed for rotating the rover in left and right direction respectively. "5" is pressed for stop the rover from moving and it comes to a standstill position.

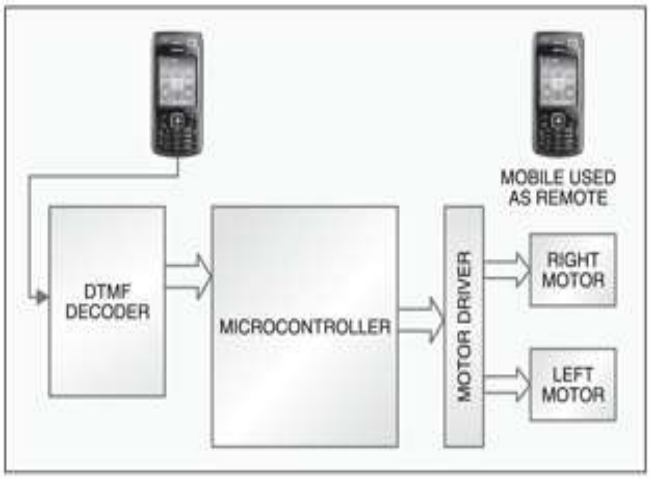

Fig1. Block diagram on cell phone operated land rover.

ACTION PERFORMED ACCORDING TO THE KEY BEING PRESSED				
No. pressed by user	**O/P of HT9170 DTMF decoder**	**I/P in the micro-controller**	**O/P from the micro-controller**	**Actions Performed**
2	0x02 00000010	0xFD 11111101	0x89 10001001	Forward Movement
4	0x04 00000100	0xFB 11111011	0x85 10000101	Left Turn, Right motor forward and Left motor backward
6	0x06 00000110	0xF9 11111001	0x8A 10001010	Right Turn, Right motor backward and Left motor forward
8	0x08 00001000	0xF7 11110111	0x86 10000110	Backward Movement
5	0x05 00000101	0xFA 11111010	0x00 00000000	Stop

Fig2. Truth table for the movement of the cell phone operated land rover.

III. PIR SENSOR

PIR (Passive infra-red) Sensors are pyro-electric sensors [2],[4],[5],[9],[13] which can detect different levels of infra-red radiations from the objects surrounding it. As shown in Fig3. a PIR motion detector sensor is divided into two parts and each part is being made up of special materials which are very much sensitive to IR. So when the sensors are idle, both of them detect the same level of IR but when a live human body which are continuously radiating thermal radiation [6],[7],[12] passes by the first part which gets intercepted of the sensor causes a positive change which causes difference in between the two parts [9]. The change in pulse is what the PIR sensor detects and accordingly raises an alarm so that the operator can hear it from a distance. This alarm is raised by a beeper present on the land rover which is directly connected to the PIR sensor [13]. The PIR sensor can detect live humans from a maximum distance of 10 meters, although its average effective range is in between 5-9 meters.

Fig3. Image showing Front and Back side of a PIR Sensor

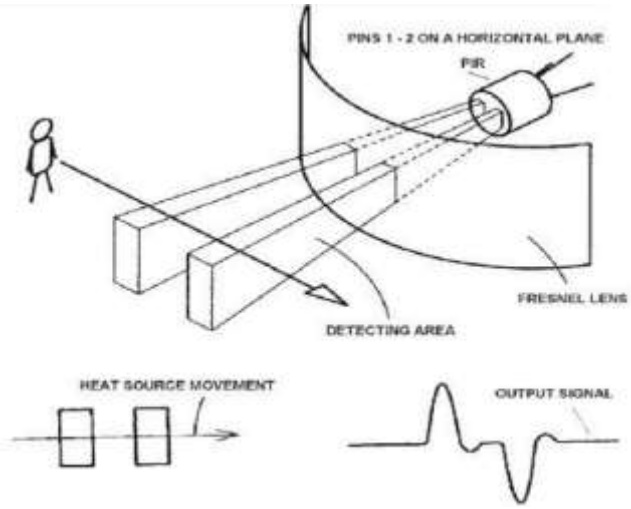

Fig4. Working Principle of a PIR Sensor.

IV. AUDIO/VIDEO CAMERA

Camera includes a lens, an image sensor and some support electronics which helps in high definition image as well as video capturing. The support electronics are present to read the image from the sensor and transmit it to the host Computer or to the Television on which the operator can see the surrounding of the disaster environment and act accordingly. At the receiving end a receiver with a TP Link antenna is present. The effective working range at which this camera can transmit and receive image signals properly is about 50 meters after which the signal may get disconnected.

V. SOLAR PANEL

Instead of using a conventional battery charger to charge the battery, here a 6V solar panel is used to charge the battery of the robot. The solar panel is placed on the top of rover above all other components. The battery of the robot can get fully charged within 7-8 hours under effective sunlight. Once the battery is fully charged the robot can work continuously for nearly 8-12 hours without failure.

VI. ADVANTAGES AND DISADVANTAGES

The advantages are:

a) Wireless Control System.
b) Surveillance System is present.
c) Unlimited range, hence better for search and rescue operations.

The disadvantages are:

a) Cell phone bills are very high.
b) Cell phone battery drains out easily so charging problem.
c) Only particular cell phones whose earpiece is attached properly can only be used.
d) If the battery charge runs out then it cannot work in the dark.

VII. CONCLUSION AND FUTURE SCOPE

With the help of these robots many lives can be saved and many others can be rescued within a short period of time which cannot be achieved though the conventional way of search and rescue operation still practiced till today.

This robot can be improved and upgraded using other higher level sensors and having more motor capacity. Some of these sensors are thermal imaging sensors, gas sensors etc can be installed additionally for more efficient work.

VIII. ACKNOWLEDGEMENT

We are extremely grateful to Pailan College of Management and Technology and its faculty members of Electronics and Communication Engineering department for giving us both the opportunity of writing and presenting this paper.

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