

Autonomous Intelligent Robot for Emergency Services

Mrs. Edwina G.Rodrigues¹, Ms. Viji Chandran², Mrs.Rekha T³
^{1,2,3}(Dept.of EEE, College of Engineering, Perumon / CUSAT, India)

Abstract: Robotics is the branch of engineering that deals with the design, construction, operation, and application of robots as well as computer systems for their control, sensory feedback, and information processing. This project aims to develop an autonomous intelligent robot which could assist humans in rescue operations during times of fire hazards. It is a fully autonomous robot which does not need any human interventions. The model is basically a 4 wheeled robotic vehicle. The robot uses an ultrasonic transmitter and receiver pair for navigation. This robot can be implemented in industries or big institutions to automatically extinguish accidental fires.

Keywords: CMOS-complementary metal oxide semiconductor, UART-Universal Asynchronous Receiver Transmitter .GPS-Global Positioning System. TX- transmitter, RX-receiver.

I. Introduction

In our lives, situations can occur when humans need to see more and beyond. Some places are hidden to human vision, are too dangerous or too far away. There is a need to equip the user with some devices which increase human perspective. For such enhancements the only technology that humans can depend on is robotics. Robotics is the branch of engineering that deals with the design, construction, operation, and application of robots as well as computer systems for their control, sensory feedback, and information processing. It is one of the most developed branch of engineering, and is now being implemented for different application on different parts of the world. Disaster management is one of such fields in which robotics is applied. The main feature of robotics is that it is a combination of various engineering technologies including mechanical, electrical, electronics and computer science. So the potential of such an integrated technology is way beyond any expectations. Rescue environments can be extremely difficult to explore due to varying and complex terrain, structurally unstable harsh environment as well as weather conditions. Rescue Robots provide a promising solution to these conflicts. The types of robots that we will encounter most frequently are robots that do work in rescue environment. Robots can carry cameras, thermal imagers, hazardous material detectors, and medical payloads into the interior of a rubble pile and set up communication link with human operator using the ad-hoc network set-up by these robots. Each robot equipped with accelerometer, gyroscope and magnetic compass as sensor devices, can plan its navigational path with reference to each other and can get the sensor network dynamically relocated. Team of mobile robots equipped with appropriate sensors and distributed and cooperative planning algorithms can also autonomously generate maps for oil spill or radiation leaks.

II. Model and Description

The model proposed here is a four wheeled autonomous robotic vehicle that assists humans during fire hazards in industries or institutions. The robot automatically detects fire with the help of temperature sensors located at different zones on the industry. Then with the help of ultrasonic sensors the robot navigate to the location and extinguishes the fire with the help of water tank and pump arrangement.

This complete arrangement has three sections. First is a zone controller section. Temperature sensors and ultrasonic transmitter are located at different zones and they are controlled by an AVR microcontroller. When flame occurs, sensors detect the fire, the controller receives the signal from that sensors and it transmitted the signal to the base section and also activated the corresponding ultrasonic transmitter. Second is base vehicle section. The controller in base section receives the signal from controller in the zone section. Navigation is carried out in the direction of ultrasonic signals with the help of an ultrasonic receiver placed in the robot. A water-pump arrangement is used to extinguish fire. Third section is control room. Current location of robot can be displaced on a PC via a wireless TX/RX in connection with a GPS controlled 8051 processor.

III. Block Diagrams and Description

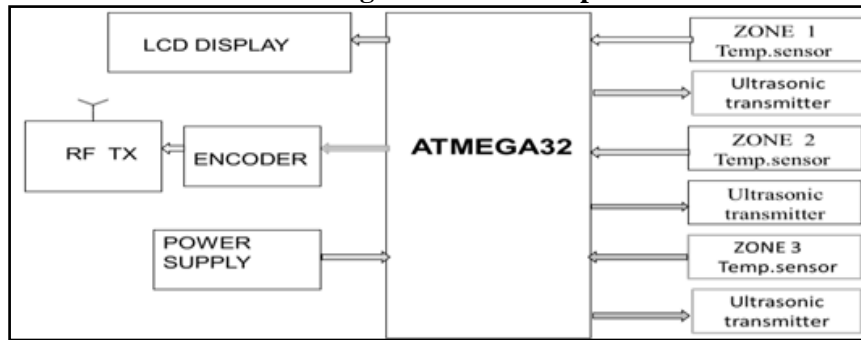


Fig 3.1 Zone control block

Zone where fire hazard has occurred is detected and information is send to the robot using this section. An ATMEGA 32 microcontroller process the signals from the flame sensors located at each zone under the occurrence of flame. An HT12E encoder encodes the processor output signal and transmits to robot by RF transmitters & also activates the corresponding ultrasonic transmitter. HD44780 LCD is provided for displaying zone data.

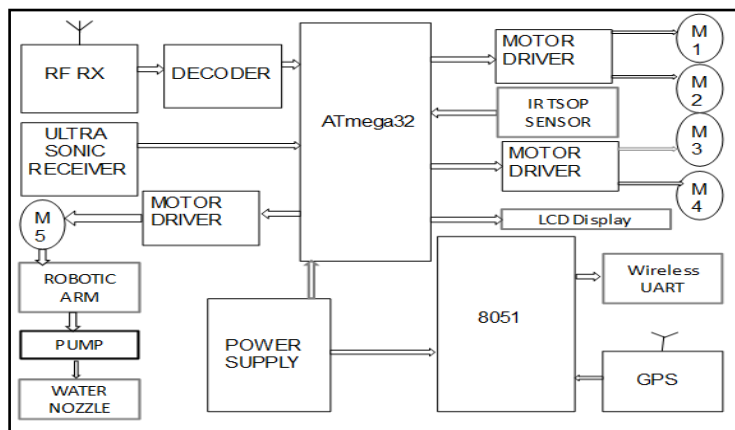


Fig 3.2 Robotic control section

The robot is controlled by a central AVR microcontroller. TSOP sensors are provided for obstacle sensing. Two motor drivers are provided for driving the motors used for locomotion and one more drive for the robotic arm. LCD display is used to display the fire occurred zone. There is a relay, which is used for operating the robotic arm and hence the DC pump. A receiver module is provided for fetching the information from the zone controller. Ultrasonic receivers placed in the robot receive the signals transmitting from ultrasonic transmitter in the zone section and by comparing these signals robot reaches the zone in which the flame occurred. Fire is extinguished with the help of water pump attached to the robotic arm. There is a dedicated 8051 microcontroller for fetching the GPS data.

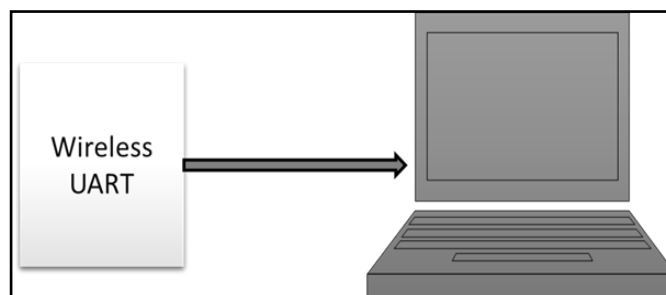


Fig 3.3. UART system connection

The data, which indicates the current position of robot is transmitted from the GPS via a wireless transmitter, is received by a wireless receiver and displayed in the computer connected to it.

IV. Flowcharts

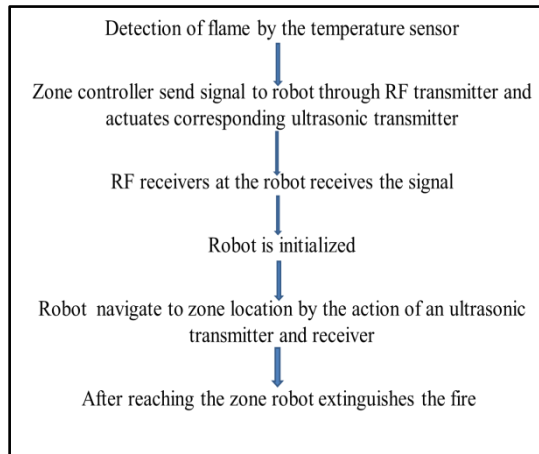


Fig 4.1. Overall Working Flowchart

This complete process is achieved by means of two separate controls. To fetch the GPS data an 8051 controller is also included. Each of the two AVR controllers is in zone and robot section. One 8051 controller is for GPS purpose.

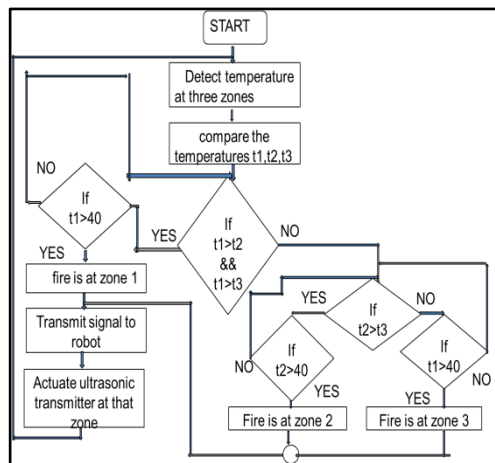


Fig 4.2 Zone Section Flowchart

The temperature sensors located at different zones are controlled by an AVR microcontroller. When one of the sensor detects a temperature more than 40degreeC it is considered as fire and it gives a signal to the AVR at zone. This will activate the ultrasonic transmitter placed at the corresponding zone. Also sends the information to the robot using an RF encoder and transmitter.

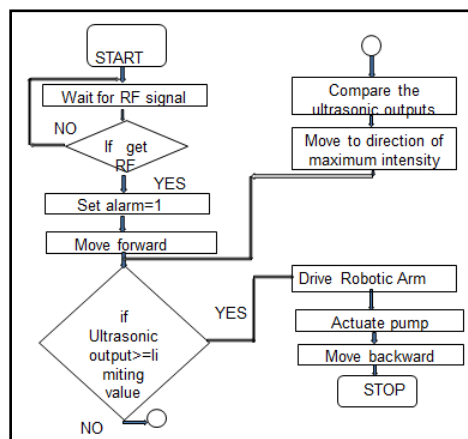


Fig 4.3 Robot Section Flowchart

This signal is received by the robot using a decoder and RF receiver. Then it is given to the main AVR controller at the robot. Now the ultrasonic receivers receives and compares the ultrasonic signal transmitted from the ultrasonic transmitter placed in the zone and move to the direction which have high intensity signal.. Once it reaches the zone, detect the exact location of fire and extinguish it with the help of robotic arm and the water pump attached to it. The pump is operated using a relay which is triggered by the main controller.

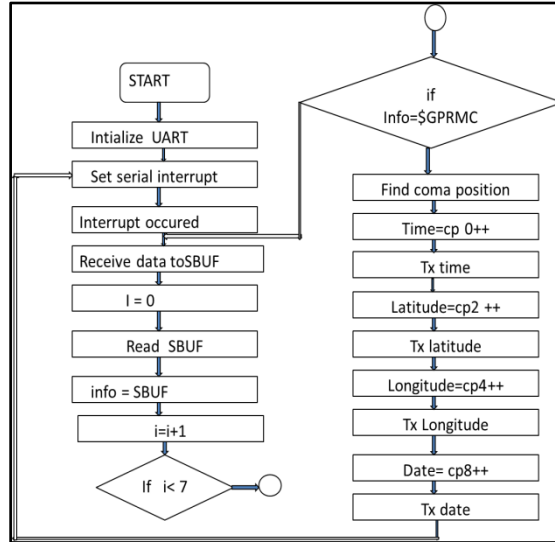


Fig 4.4 GPS Section Flowchart

The GPS programming is carried out through an 8051 microcontroller unit. For fetching the GPS data serial port settings are done in the controller. After the initialization of UART the controller is checking for interrupt .if any interrupt is occurred, the data reception starts. The received data is stored in the SBUF register. GPS is inbuilt with different codes. The actual code needed is \$GPRMC which includes latitude, longitude, date, time etc. The controller compares the received data with the required one and transmit only the required data's to the computer through a wireless RF TX/RX.

V. Navigation System

Navigation system is carried out with the help of an ultrasonic transmitter receiver pair. Ultrasonic transmitter placed at the zone actuated under the occurrence of flame. Ultrasonic receivers placed at the robot receive and compares the signals. The robot is moves in the direction of maximum intensity.

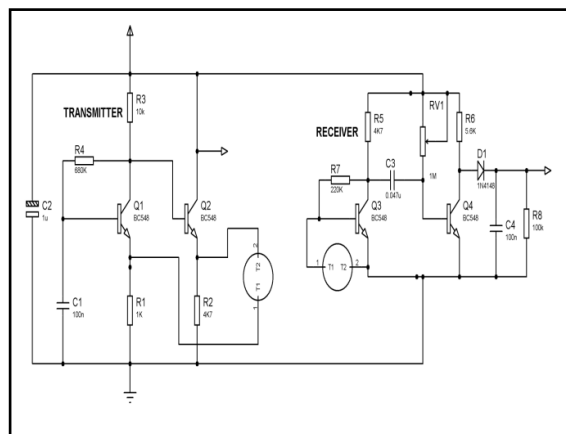


Fig 5.1 Ultrasonic Transmitter And Receiver Circuit

Ultrasonic transmitter and receiver pair of 40KHz is used with an amplifier oscillator circuit. Ultrasonic waves are produced in the transmitter by piezoelectric effect. The electric potential is applied across the piezoelectric crystal placed in the sensor by the transistor circuit. Received signal in the receiver is amplified by an another transistor circuit.

VI. Components Used

The main components used in the proposed system are given below.

- 1) 12V battery
- 2) Geared motors of 30 rpm.
- 3) ATmega32
- 4) AT89S51
- 5) GPS Module and antenna
- 6) Temperature sensors
- 7) Ultrasonic transmitter receiver pair
- 8) TSOP sensor
- 9) L293D motor driver ICs
- 10) DC pump
- 11) HT12E & HT12D RF communicators
- 12) Wireless UART communicators

6.1. Ultrasonic sensors

Ultrasonic sensors can be used to solve even the most complex tasks involving object detection or level measurement with millimeter precision, because their measuring method works reliably under almost all conditions. In industrial applications, ultrasonic sensors are characterized by their reliability and outstanding versatility. It has excellent directivity and sensitivity. Detection Range is about 12m. Nominal frequency of operation is 40kHz and operating temperature is -30°C to +85°C. A single ultrasonic transducer is used as both emitter and receiver and is typically contained in the same housing. It's ideal for use in alarm systems and object detection.



Fig 6.1. Ultrasonic Sensor

6.2. Geared Motor

30 RPM Side Shaft 37mm Diameter High Performance DC Gear Motor is suitable for small robots / automation systems. It has sturdy construction with gear box built to handle stall torque produced by the motor. The torque is about 5Kgc.m. Drive shaft is supported from both sides with metal bushes. Motor runs smoothly from 4V to 12V and gives 30 RPM at 12V. Motor has 6mm diameter, 18mm length drive shaft with D shape for excellent coupling



Fig 6.2 .Geared Motor

6.3 Wireless UART

Wireless UART Connector is a four pin IC. They are RXD, TXD, VCC and GRND. RXD receive serial data of 3 to 5V logic level, usually connected to TXD pin of microcontrollers. TXD transmit Output serial data of 3V logic level, usually connected to RXD pin of microcontrollers. VCC is regulated 5V supply input. GND is Ground level of power supply, must be common ground with the microcontroller. It has a working voltage range of 4.5 to 9V. The frequency of operation is about 2.4 GHz

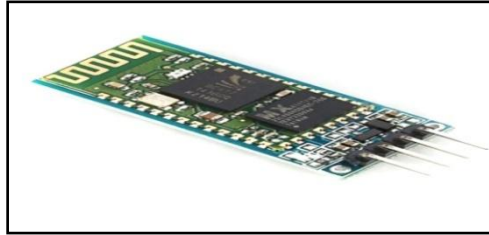


Fig 6.3.Wireless UART Connector

6.4. HT12E & HT12D

The HT12E Encoder ICs are series of CMOS LSIs for Remote Control system applications. They are capable of Encoding 12 bit of information which consists of N address bits and 12-N data bits. Each address/data input is externally ternary programmable if bonded out.

The HT 12D ICs are series of CMOS LSIs for remote control system applications. These ICs are paired with each other. For proper operation a pair of encoder/decoder with the same number of address and data format should be selected. The Decoder receive the serial address and data from its corresponding decoder, transmitted by a carrier using an RF transmission medium and gives output to the output pins after processing the data.

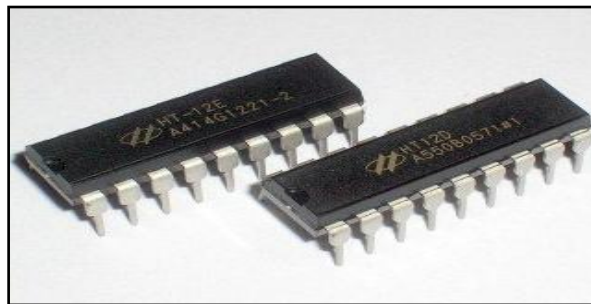


Fig 6.4. Encoder and Decoder

6.5. Microcontrollers

6.5.1 ATMEGA 32

ATMEGA 32 is manufactured by ATMEL. It has 32Kbytes of In-System Programmable Flash Program memory with Read-While-Write capabilities, 1024bytes EEPROM, 2Kbyte SRAM, 32 general purpose I/O lines, 32 general purpose working registers, a JTAG interface for Boundary scan, On-chip Debugging support and programming, three flexible Timer/Counters with compare modes, Internal and External Interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, an 8-channel, 10-bit ADC with optional differential input stage with programmable gain, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and six software selectable power saving modes. The inbuilt ADCs present in the controller is of successive approximation type. It has a speed of 1 MIPS for a clock frequency of 1 MHz. The Idle mode of controller stops the CPU while allowing the USART, Two-wire interface, A/D Converter, Timer/Counters, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the hardware Reset. In Power-save mode, the Asynchronous Timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except Asynchronous Timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

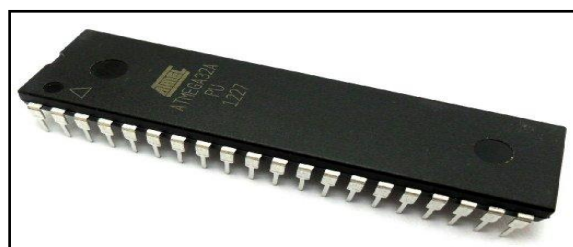


Fig.6.5.ATMEGA32 microcontroller

6.5.2. AT89S51

The AT89S51 is a low-power, high-performance CMOS 8-bit microcontroller with 4K bytes of In-System Programmable Flash memory. The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard 80C51 instruction set and pinout. 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 AT89S51 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications.

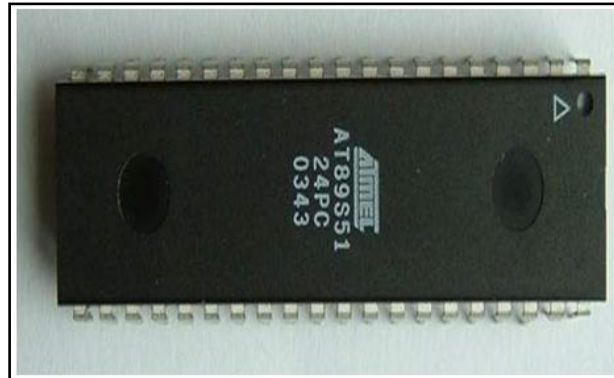


Fig 6.5.2. At89s51 Microcontroller

6.6. GPS Receiver and Antenna

GPS receivers receive almanac data from the satellite and also calculate their position by calculating its distance from then visible satellites and then by using triangulation method to calculate its position. GPS receivers also work on these NMEA Standards. After the data has been received and position has been calculated, the data is configured according to standards set up by NMEA (National Marine Electronics Association) and is serially transmitted at a baud rate of 9600 bps. The National Marine Electronics Association has developed standards that describe the interface between various marine electronic equipment's. The data given by the GPS receiver includes many information like position (latitude and longitude), altitude, speed, time etc. In its standards, NMEA has specified to send a series of data in a sentence



Fig 6.6 GPS Receiver and Antenna

6.7. TSOP Sensor

The TSOP 1738 is a member of IR remote control receiver series. This IR sensor module consists of a PIN diode and a pre amplifier which are embedded into a single package. The output of TSOP is active low and it gives +5V in off state. When IR waves, from a source, with a centre frequency of 38 kHz incident on it, its output goes low. Lights coming from sunlight, fluorescent lamps etc. may cause disturbance to it and result in undesirable output even when the source is not transmitting IR signals. A band pass filter, an integrator stage and an automatic gain control are used to suppress such disturbances. TSOP module has an inbuilt control circuit for amplifying the coded pulses from the IR transmitter. A signal is generated when PIN photodiode receives the signals. This input signal is received by an automatic gain control (AGC). For a range of inputs, the output is fed back to AGC in order to adjust the gain to a suitable level. The signal from AGC is passed to a band pass filter to filter undesired frequencies. After this, the signal goes to a demodulator and this demodulated output drives an npn transistor. The collector output of the transistor is obtained at pin 3 of TSOP module.

Members of TSOP17xx series are sensitive to different centre frequencies of the IR spectrum. For example TSOP1738 is sensitive to 38 kHz whereas TSOP1740 to 40 kHz centre frequency

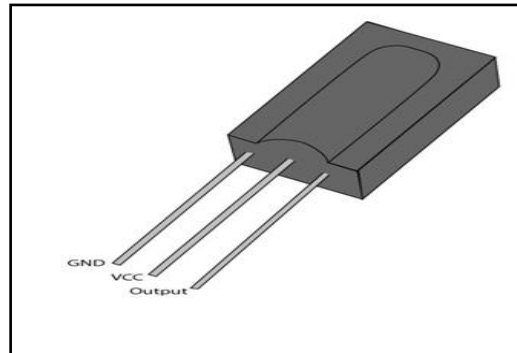


Fig 6.7. TSOP Sensor

6.8. LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55 to $+150^{\circ}\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy

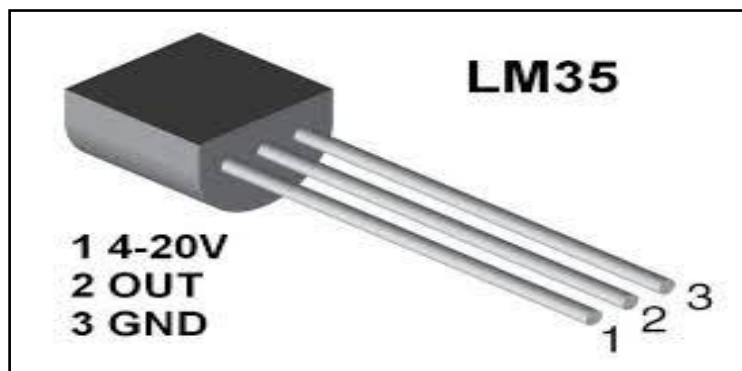


FIG 6.8. LM35 Temperature Sensor

VII. Hardware

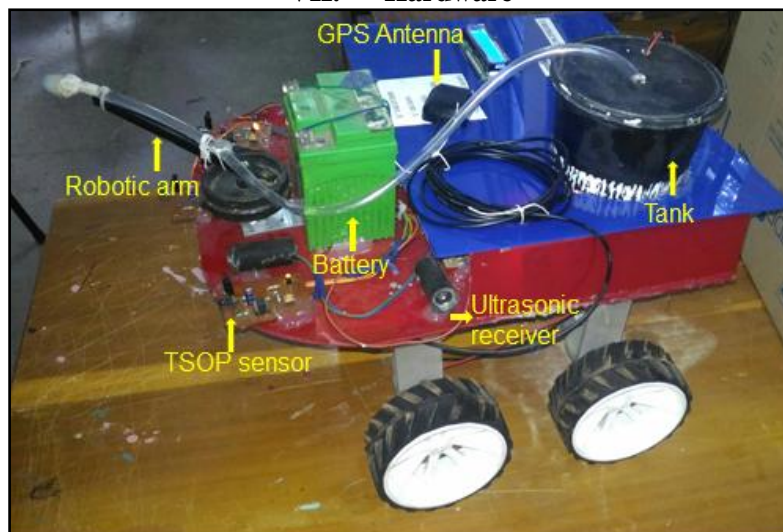


Fig 7.1. Robot

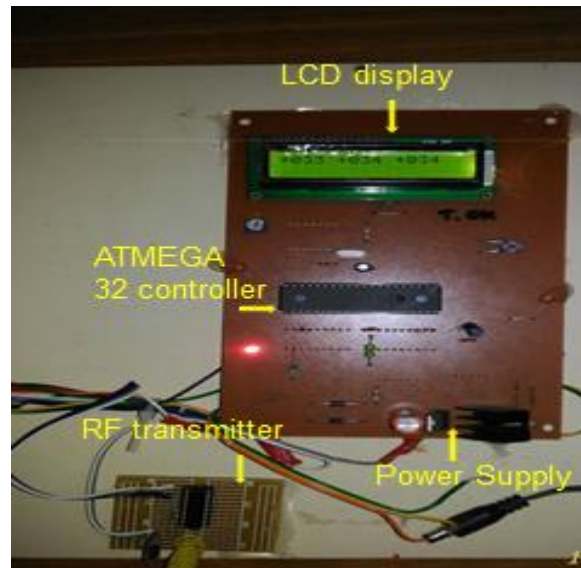


Fig 7.2. Zone controller

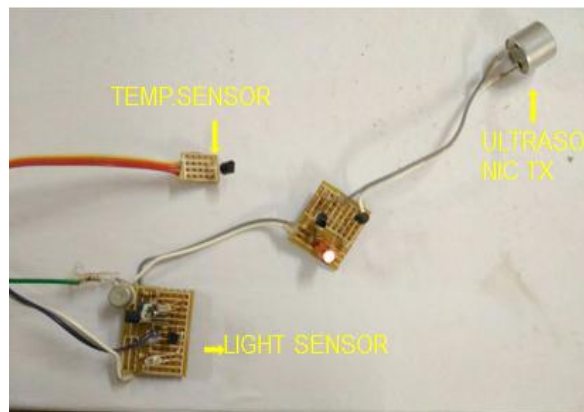


Fig 7.3. Sensors at the zone

VIII. Conclusion

The robot proposed in this project has high significance in the present life. Every people are busy and they do not get enough time to deal with safety. Many life's are losses during rescue operation. The proposed robot is a dedicated intelligent device which continuously surveys for any fire hazards. After detecting fire it automatically navigate to the desired location and extinguish the fire.

References

- [1] GPS and sonar based area mapping and navigation by mobile robots, Ray, A.K. ; Dept. of Electrical. Eng., Indian Inst. of Technol., Kanpur, India. Industrial Informatics, 2009. INDIN 2009. 7th IEEE International Conference on June 2009
- [2] Robert I. Egbert and Joseph E. King *The Gps Handbook: A Guide for the Outdoors*, 2003 :Burford Books
- [3] Lawrence Letham *Gps Made Easy: Using Global Positioning Systems in the Outdoors*, 2003 :Mountaineers Books
- [4] Irving M. Gottlieb *Electric Motors and Control Techniques*, 1994 :McGraw-Hill/TAB Electronics
- [5] MykePredko and MykePredko *Programming Robot Controllers*, 2002 :McGraw-Hill/TAB Electronics