International Journal of Engineering Research in Electronic and Communication Engineering (IJERECE) Vol 2, Issue 9, September 2015

# Intelligent Fire Sensing and Extinguishing Robot

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***Abstract:*— A fire fighter run into risky situations while extinguishing fire and rescuing victims. In contrast, a robot can function automatically or can be controlled from a distance, so that firefighting and rescuing activity could be executed by using a robot instead of putting fire fighters at risk. This robot uses gear motors, microcontroller, sensors, RF controller and an extinguisher. Microcontroller acts as the brain of the robot. Fire Fighting Robot continuously monitors the temperature of four temperature sensors fixed at four sides of the robot and if presence of fire is found to be true, the robot moves in the direction to which the temperature is relatively high among the four sensors and puts down the fire with the extinguisher. As the fire sensors sense the fire, it sends signal to the microcontroller via a comparator circuit. As soon as microcontroller receives the signal an alarm sounds. Also a predetermined message will be sent to the fire station using GSM modem. After sounding the alarm microcontroller drives the robot towards fire place. As the robot reaches near the fire source, the extinguisher is turned on and the fire is extinguished. Also any obstacle in its path can be detected by means of an ultrasonic wall detector. If the robot gets blocked or trapped in any situations inside a room, the robot can be externally controlled by using an RF controller from outside.**

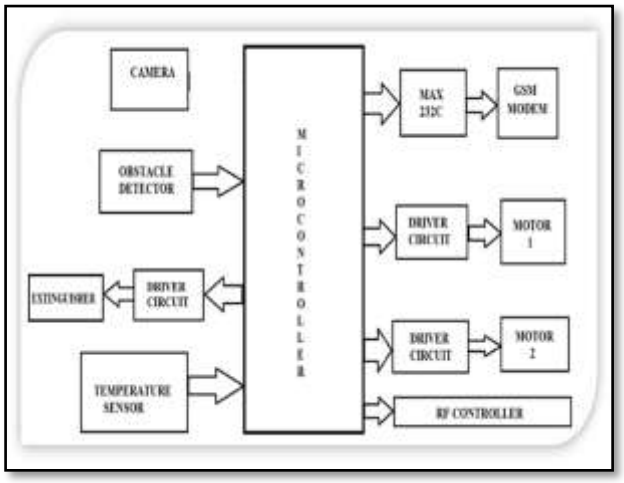
***Keywords***: **fire fighting; temperature sensor; direction control; GSM interfacing; extinguisher; RF controller; ultrasonic wall detector**

## I. INTRODUCTION

Robots are defined as electro-mechanical devices that are designed to assist people, to make acute tasks effortless but accurate execution or to use for production purpose in any industry. The foremost application of robots has so far been in the automation of mass manufacturing industries, where the identical defined tasks are to be performed repeatedly in exactly the same manner but definitely maintaining an optimum accuracy rate. However, in the recent times, there has been interest in also sending robots into such situations that are too dangerous for a person to go. For instance, buildings that are set on fire or collapsed after an earthquake needs immediate rescue operation, it is safer to send an autonomous robot into the building to investigate surrounding condition, and then let the rescue teams enter. There are also some other robots which are used in more dangerous circumstances like in bomb disposal, detecting mining bomb or cleaning of deadly nuclear toxic wastage. The device employs array of temperature sensors to localize heat sources and press the nozzle of the extinguisher or cylinder through mechanically designed switch[1]-[3]. Ultrasound range sensor on the other hand will be utilized to detect obstacles. If any reflection occurs from anywhere, it has a high possibility that there might be any human on danger and that time robot will automatically start spraying extinguishing materials from cylinder. All of these functions are directed by 89S52 microcontroller with the help of the software.

## II. THE SYSTEM ARCHITECTURE

The system architecture consists of fire fighting robot, the appliance control, GSM module, RF controller module and a video streaming mechanism using a Wi-Fi camera. Firstly the status of ultrasonic wall detector is checked, if an obstacle is detected then the robot will revert its direction. If an obstacle is not detected it will move in the same direction. The fire detection is done using a temperature sensing mechanism by the four LM35 temperature sensors placed at four sides of the robotic vehicle[6]. The sensors compare the surrounding temperature with a threshold value and if it is above the threshold value 1st message is send through GSM to a mobile and if it exceeds a higher threshold, then the fire message is passed to fire station. If fire detected, then switching circuit is activated and the extinguisher is turned ON. The direction of motion of the robot is to the direction of higher fire intensity and it is measured via the four temperature sensors at the four sides of the robot[3].




***Block Diagram of Proposed Model***

The motion of the robot is controlled by the intensity of the fire and is programmed by the microcontroller. Microcontroller is the heart of the project. The Micro Controller having the internal memory to store the data or written program by the user and also having the control system to control the input and output data corresponding to the internal program written by the user. All the components like wall sensor, temperature sensor, driver circuits and extinguisher are connected to the Microcontroller with the help of connecting tracks.

In this robot as the fire sensor senses the fire and sends the signal to microcontroller. Since the output of the sensor is very weak, a comparator is used so that its output is send to microcontroller. A buzzer sounds as soon as the microcontroller receives the signal. The buzzer sound indicates the occurrence of fire accident. The microcontroller drives the robot towards the source of fire, as the robot reaches near the fire source the microcontroller actuates the gear motor and extinguisher's nozzle is pressed and it releases fire suppressing gases so that fire is extinguished[4].

The microcontroller can also switch ON the extinguishers in the room and a rapid spread of the fire can thus be avoided. With the assistance of a Wi-Fi/CCTV camera, we can check whether the robot is trapped or not. If any assistance needed, it can controlled by a specific person standing in a certain range by a RF Transmitter-Receiver module. The entire circuit excluding the fire sensors is implemented inside a wooden covering since it won't conduct heat. This setup can be again covered by an aluminum sheet since it has high melting point and is protected from the fire.

***Microcontroller :***

The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash Programmable and Erasable Read Only Memory (PEROM)[8]. 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 Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications[8].

***Fire sensors:***

The LM35 series are precision integrated-circuit 1temperature devices with an output voltage linearly-proportional to the Centigrade temperature[6]. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 μA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range.

***GSM Modem:***

GSM modem is used to convey the occurrence of fire accident via SMS. Here using GSM modem a predetermined warning message is send to required persons and if fire is out of control, a help request is send to fire station so that they get alerted and reach the place quickly where fire broken out.

***Motor and Driver Circuit:***

Gear motors are more powerful than servos in terms of speed and torque. The 12V DC Geared Motor can be used over a range of robotics applications and is available with wide range of RPM and Torque. The motor here used is a 45rpm medium torque gear motor. The current coming from microcontroller alone cannot drive the motor, so we use a driving circuit. The driving circuit consists of a motor driver IC L293D. The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive

currents of up to 1 A at voltages from 4.5 V to 36 V. The L293D can provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V and all its inputs are TTL compatible.

***Chassis:***

A chassis can also be called as a robotic base. All components and the entire circuitry of the robot are attached directly to the base/ chassis, therefore a strong but light chassis will be preferred. Chassis can be made from any type of material. Commonly we use aluminum, acrylic, steel, plastic or high density polymer.

***Obstacle Detector:***

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the accuracy of ranging can reach to 3mm. The module includes ultrasonic transmitters, control circuit and receiver[7]. The basic working principle:

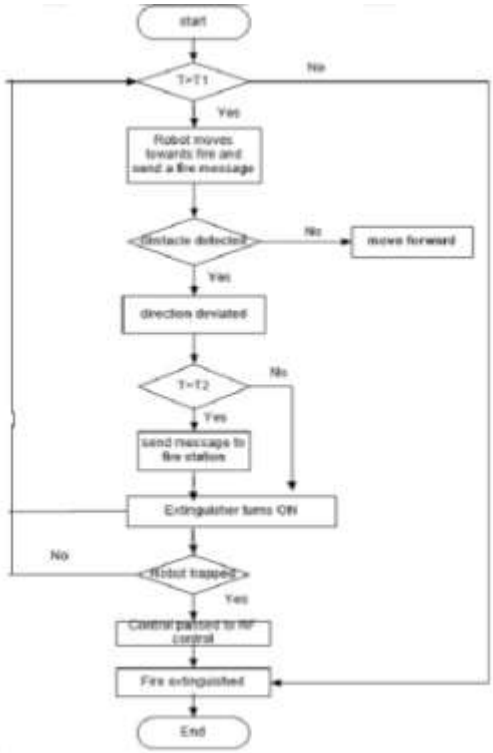
(1) Using IO trigger for at least 10us high level signal,

(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

Test distance = (high level time *velocity of sound (340M/S) / 2)

## III. WORKING:

12V dc supply is provided to the entire circuit. A sudden change in the power may cause data error resulting in the corruption of the internal program of the microcontroller. The reset logic circuit contains one capacitor and a resistor. The thermal sensors provided can sense the heat from within the room. First sensor will give the data to the micro controller if it finds the heat. The micro controller pin bit goes from low to high when the fire is present. The micro controller will always scan the input signal of sensors. If the front sensor gives the data about fire to the micro controller, it then finds the path to reach the fire source by comparing with other input data. The microcontroller gives the output to both the motors via L293D motor driver. First motor is for the right side wheels and the next for left side wheels. To move the robot forward, both the motors are rotated in clockwise direction




***Flow Chart***

and to move it to backward, both are in anticlockwise direction. To turn it left, the left side motor rotates in clockwise direction and right side motor in anticlockwise direction. Vice versa to turn it right. The ultrasonic sensor senses the presence of any kind of obstacle in the front within a distance. If the presence is sensed true, the robot changes its path to right direction and continues its motion. If in case the robot is trapped in a situation, we require an external human control. For that a four bit RF R-T module is also incorporated in the robot. After the robot reaches near the source, movement is paused and the motor fixed for the operation of the extinguisher is partially rotated and the nozzle of the extinguisher is pressed and released. Thus the fire is extinguished. To protect the circuit from fire and heat, a two layer protection system is used. The entire circuit excluding the fire sensor is first implemented inside a wooden covering since it won't conduct heat and this setup can be again covered by an aluminum sheet since it has high melting point and won't catch fire. The flow chart of the working of the model is illustrated in fig2.

## IV. ADVANTAGES

The proposed model is advantageous because:

- Reducing human involvement in the hazardous situations.
- Automatic movement of robot towards fire source.
- Sending message to the fire station increases the efficiency when the fire exceeds beyond the control of robot.
- External control is an added favor.

## V. DISADVANTAGES

The major disadvantages are:

- The robot cannot move through rough terrains.
- The range of detection of fire is limited.

## VI. FUTURE SCOPE

In real time application, the temperature sensors can be replaced with IR flame detectors or any advanced fire detection system so that the presence of flame can be detected from far beyond. Also a Wi-Fi camera attached with the robot increases its application in the real world. The gear motor used here cannot serve a higher load. It can also be replaced in case of special situations. The microcontroller can also switch ON the extinguishers present in the room in case of emergency.

## VII. CONCLUSION

Fire accidents can occur anywhere at any time and it rapidly spreads causing havoc. The proposed fire fighting robot is an efficient and cost effective model that can help to extinguish fire in hazardous situations. It detects the presence of fire, moves towards fire avoiding all obstacles in its path, reaches the source and put down the fire automatically. Also the robot can be externally accessed in case of any emergency. The model has a social relevance and meets economical barriers.

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