

Autonomous Fire Fighting Robot

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Abstract: Now-a-days, fire accidents are very common. Fire incident is a disaster that can potentially cause the loss of life, property damage and permanent disability to the affected victim. So, firefighting robots can be widely useful in industries or localities where the probability of accidental fire is more. The robot is designed to be compact in size than other conventional firefighting robot to ease small location entry for the deeper reach of extinguishing the fire in narrow space. The proposed vehicle can detect presence of fire and extinguish it automatically by using IR flame sensor, temperature sensor. It contains DC motors and motor driver to control the movement of the robot. And when it will detect fire then it will communicate with firefighters through text messages about the happening fire accident. The proposed robot has a water jet spray which is capable of sprinkling water. And the water level in tank is also monitored continuously and user is updated with the information of source availability. At the time of moving towards the source of fire, it may happen that it will come across some obstacles. Hence, it has obstacle avoiding capability to avoid it from hitting any obstacle for fire detection. It detects obstacles using ultrasonic sensors up to a range of 80cm. This increases capabilities of identifying fire locations automatically and ability to extinguish fire remotely at particular distance. The designed robot can also be controlled manually through Bluetooth.

Keywords: Arduino Mega, Battery, Flame sensor, GSM module, Temperature sensor, Ultra sonic sensor.

1. Introduction

A lot of fire accidents take place frequently across the globe taking lives of many. As we all know fire accidents are fatal accidents which kill many and destroy a lot of property. According to the National Crime Records Bureau (NCRB), more than 1.2 lakh deaths from fire incidents in India from 2010-2014 are reported to have been caused. Although many precautions have been taken for Fire accidents, these natural / man-made disasters do occur now and then. In case of a fire breakout, we are forced to use human resounding to rescue people and put out the fire. Many firemen's lose their life during rescue operations while saving people who are stuck in fire accidents. According to Indian Risk Survey 2017, annually 100-200 firemen lose their life during rescue operations across India. Fire Fighting and rescue of people trapped in fire incidents is a dangerous task. Firefighters face many dangerous situations while the fire is extinguished. In houses, fire fighters

extinguish the flames, pull heavy hoes, climb high ladders and bring victims from one building to another. Long and erratic working hours they have to do their job. Firefighters often face unfriendly conditions such as high temperature, low humidity and dust etc. Besides these, they must combat life-threatening situations such as the explosion and collapse of buildings. Firefighters confronting risky situations while extinguishing the fire and rescuing victims are an inevitable part of a fire. Taking into account the challenges faced by a team of human fire extinguishers in arriving at the scene of a fire accident in the least possible time and dealing with the fire with the few resources at their disposal, it is solved by designing a robotic fire extinguishing vehicle which can act more spontaneously to fire and make its fire-fighting mechanism more efficient and help firefighters. With the development of technology in Robotics in particular, it is very likely to replace humans with robots to battle the fire. That would increase firefighters' productivity and also keep them from losing their lives. To put it another way, robots reduce the need for firefighters to get into dangerous situations. Robot is an artificially controlled computer, capable of carrying out project, which is our effort to design a Fire Fighting Robot, consists of a computer that not only has the basic characteristics of a robot but can also detect and extinguish fire. This robot processes information via microcontroller from its various sensors and key hardware elements. Flame detectors are to be used for initial flame detection. Once the flame is detected, the robot uses buzzer to sound the alarm and reach the fire arena to avoid the obstacles on the path. Once the robot reaches the fire arena, it actuates an electronic valve which releases water sprinkles on the fire. This robot provides fire protection when a domestic or industrial fire occurs by using automatic robot control by using a microcontroller to reduce life-loss and property damage.

2. Literature Survey

On survey about various methods of implementation of firefighting robot, we came across four types. The various types are autonomous robot, android application based, DTMF (Dual Tone Multi Frequency) based robot and voice-controlled robot. The autonomous robots can be made with the metal detectors which could detect bombs as well. The voice operated robots

are controlled by operator voice commands. Android controlled robot is the one which is completely controlled by android mobile application with operator commands. DTMF robot which is one of the intelligent and cost-effective robot which are activated by sound signal [1]. The robot can be built with dual modes, auto and operator controlled mode. The robot can avoid obstacles on its way with pre-defined algorithm. Live surveillance of the fire areas can be achieved through camera installed in the system. The operator can see the camera visuals through a smartphone connected to the module through Bluetooth. Hence the operator can easily operate the robot and put off fire efficiently [2]. To extinguish fire more efficiently by robots, the robot can be programmed with the condition. The extinguish operation starts only if the temperature exceeds a pre-defined temperature. All the temperature values are recorded through the Bluetooth model in a mobile phone that is connected to the robot [3]. Domestic robot can also be developed with pre-defined area of the locality. In such robot a single flame sensor can be used for 360-degree flame detection. The robot rotates a full 360 degrees and detects the direction of fire and starts extinguish operation. Instead of water to extinguish fire efficiently. Since the locality is pre-defined the location of the robot can tracked using digital compass [4]. With surveillance and manually operation feature, the robot can also be featured with mike and speaker, so that operator can interact with people struck in the fire affected area. For extinguish of fire both water and carbon-di-oxide spray, solenoid valve can be used [5]. Fire fighting robots can also be built for forest fire purpose where heavy trucks or human can't reach those high terrains. For that kind of projects detailed calculation of weight balance of robot, the tensions on the robot chassis, and the torque needed to carry the whole weight of the robot at high terrains are necessary. Instead of wheels, the robots can be constructed using gear chains which help movement even in hard terrains, which also capable of climbing high terrains easily and also can descend slopes easily [6].

3. Proposed System

The system on initialization starts checking continuously for the presence of fire in the surroundings and any sudden change in the temperature. If any fire is detected, then immediately the system should send a text message to user about the occurrence of the fire through GSM and should alert the surrounding through the buzzer. If the temperature value exceeds 70, then the system should send a text message to the user as "need assistance" Because the system cannot perform above 70°C. Then the system should ask the user to specify the mode of operation. The user decides the mode of operation i.e., either autonomous mode or manual mode. If auto mode is selected, then the system should start functioning autonomously. The system will start its movement to reach the fire affected area. On traversing the path, the obstacle detection algorithm is used to detect any presence of obstacle on the way to the fire arena. If an obstacle is found, then the system should change its path

and reach its destination. On reaching the destination, the system should start extinguishing the fire by making pump HIGH and hence extinguish fire through throwing water on the fire. Once the front IR sensor goes LOW, states that the fire is put off successfully and hence the system should stop extinguish operation by making pump LOW. If the user selects manual mode, then the system should perform the commands/instructions of the user serially. The water level in the tank should be continuously monitored and the user should be alerted once the water level goes below 20% of the tank storage.

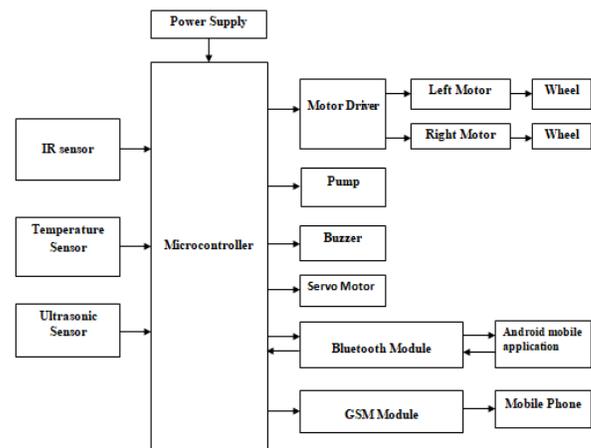


Fig. 1. Block diagram of proposed system

The extinguishing procedure starts with the detection of fire using IR sensors which is an input sensor connected at the different levels of the chassis. As we know IR sensors have an IR RECEIVER which is used to detect the fire. When fire burns it emits a small amount of infra-red light, this light will be received by the IR receiver on the sensor module. Then op-amp in IR sensor checks for a change in voltage across the IR receiver, so that if a fire is detected the output pin of the op-amp will give 5v (HIGH) and if there is no fire the output pin will be 0v (LOW). So, we place these sensors in all directions of the robot to sense in which direction the fire is burning. Once the fire is detected the IR sensor feeds the signal to the microcontroller. Immediately after fire detection, the microcontroller gives the input to the motor driver which drives the robot near the fire. Ultrasonic sensors are used to detect any obstacles present on the way to the fire area. If any obstacle present, the robot changes the path and reaches the destination.

The microcontroller activates the GSM module along buzzer to alert the firemen (operator) about the happening fire accident. GSM module is used to send text messages to the operator's mobile phone about fire detection and extinguish completion. The temperature sensors are used to detect the intensity of the fire, if the intensity of the fire is very high then an alert is sent to firemen to get further assistance. Also, through GSM alert messages about the amount of water availability in the container is sent to the operator. And buzzer alerts the people around the

fire accident area.

The movement of robot as well as alerting are operations which are performed simultaneously. Once the robot reaches the fire accident area the relay drivers will turn 'ON' the pump which pumps the water through a sprinkler and the fire is extinguished. Once the fire is put 'OFF' all the IR sensors values goes low, then relay drivers turn 'OFF' the pump and also, the buzzer is turned 'OFF'.

The system can also be operated manually through Bluetooth.

4. Experiment and Result

A. Flow Chart

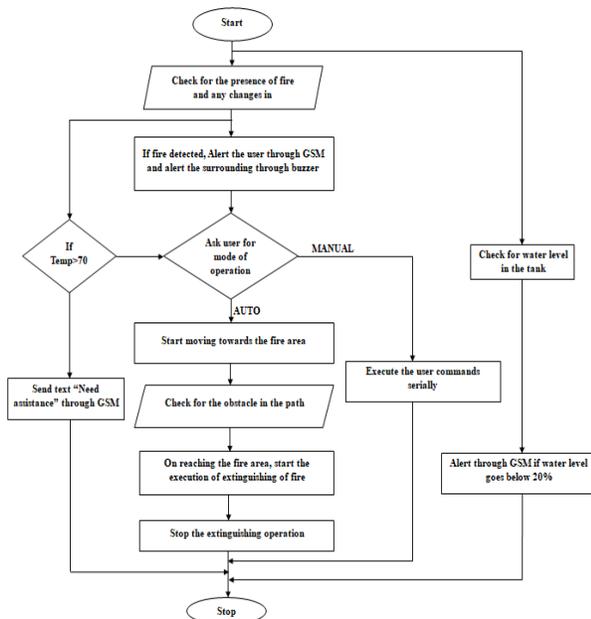


Fig. 2. Flow chart of the system

- The system on initialization starts checking continuously for the presence of fire in the surroundings and any sudden change in the temperature.
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- Then the system should ask the user to specify the mode of operation. The user decides the mode of operation i.e., either autonomous mode or manual mode
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- On traversing the path, the obstacle detection algorithm is used to detect any presence of obstacle on the way to the fire arena. If an obstacle is found, then the system should change

its path and reach its destination

- On reaching the destination, the system should start extinguishing the fire by making pump HIGH and hence extinguish fire through throwing water on the fire.
- Once the front IR sensor goes LOW, states that the fire is put off successfully and hence the system should stop extinguish operation by making pump LOW.
- If the user selects manual mode, then the system should perform the commands/instructions of the user serially.
- The water level in the tank should be continuously monitored and the user should be alerted once the water level goes below 20% of the tank storage.

Image of Android Bluetooth controller app

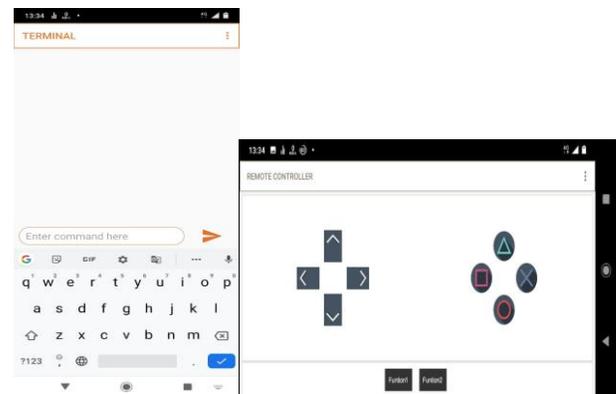


Fig. 2. The user end displays of the Bluetooth app Circuit diagram

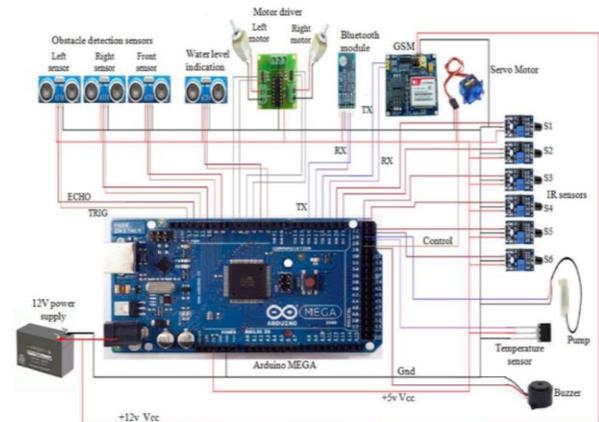


Fig. 3. Circuit diagram

- The Arduino Mega is powered with a 12V battery.
- All the sensors are powered with 5V power supply from the Arduino.
- The fig shows the complete details of the pin connections of the Arduino and sensors.

B. Result

The proposed project was physically built and tested. The results of the proposed system were as mentioned in the table. We performed various trials and all trails were successful.

Through these successful trials we were able to conclude that this autonomous firefighting robot is a better tool in fight against fatal fire accidents and thus prevent risking of firemen's life.

Table 1

No. of trials	Success	Failure
1	Yes	No
2	Yes	No
3	Yes	No

5. Conclusion

At the end of the project we were able to analyze the problems faced by the fire fighters and could design a robot which could detect fire continuously and can take necessary actions required autonomously. We designed a robot which can also be controlled manually through Bluetooth. The robot could alert the surroundings and the user about the occurrence of the fire accidents.

6. Future Scope

According to India risk survey 2017, the report states that annually 100-200 firemen lose their lives while fire rescue operations across India. So the project will help to make the vehicle unmanned so that there will be no risking and sacrifice of firemen's life during fire accidents. Since it is automated

with sensors and GSM module even if there is no human present in the surroundings, the fire is automatically extinguished along with an alert message to firemen's (operators). In the present condition, it can extinguish the fire only by water. It can also be extended to a fire extinguisher using carbon-dioxide carrier by replacing the water carrier.

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