

An Automated Fire Fighter Robot

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Abstract

The aim of this project is to contribute to the development of automation systems and to design an unmanned fire extinguisher robot. One of the most efficient tools for early extinguishment of fire is fire fighter robot. A fire fighter robot is fabricated providing extinguishment platform. The base of the robot is made of aluminium foil. There is about 1/2 liter water reserving capacity. An arduino based simple algorithm is used for detection of fire and measurement of distance from fire source while the robot is on its way to extinguish fire. When the fire is detected and the robot is at a distance near to fire, a centrifugal pump is used to throw water for extinguishment purpose. A water spreader is used for effective extinguishing. It is seen that velocity of water is greatly reduced due to the use of water spreader. Arduino Flame Sensors are used to detect the fire, Ultrasonic sensors are used to detect obstacles on the way and distances on its way towards fire.

Keywords — Firefighter, Robot, Sensors, Extinguishment

I. INTRODUCTION

Robotics is one of the fastest growing engineering field of today. Robots are designed to remove the human factor from labor intensive or dangerous work and also to act in inaccessible environment. The use of robots is more common today than ever before and it is no longer exclusively used by the heavy production industries. In Industry oil and many other inflammable materials are used for production and other industrial purposes. Under such conditions the chance of fire accidents are more. So a suitable protective measure to extinguish the fire in case of fire accidents within the workplace should be employed. The types of Fire that may occur can be classified as under:

- A – Class (Caused due to wood and wooden material)
- B – Class (Caused due to oil)
- C – Class (Caused due to fuel stored in tanks).

The need of Fire extinguisher Robot that can detect and extinguish a fire on its own is long past due. With the invention of such a device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire. Our task as engineers was to design and build a prototype system that could autonomously detect and extinguish fire. Also aims at minimizing air pollution around. In this Project we design a wireless controlled Robot. It is the Robot that can move through a model structure, find a burning and then extinguish it with help of a Water Jet.

Robots are intelligent machines that can be controlled according to need. If a multimedia interface is provided, it further aids in navigation of the robot. Making the robot wireless increases the effective area of operation, Keeping all the above factors in mind we have used very basic concept here. Many house fires originate when someone is either sleeping or not at home. With the invention of such a device, people and property can be saved at a much higher rate with relatively minimal damage caused by the fire.

In this Project we design a Fuzzy based Microcontroller controlled Robot. It is the Robot that can move through a model structure, find lit candle and then extinguish it with help of a Water Jet. This is meant to simulate the real world operation of a Robot performing a fire extinguishing function in an given area.

II. LITERATURE REVIEW

Sr. no	Paper	Description
1	Systems, Man and Cybernetics, 2006. SMC '06. IEEE International Conference on 8-11 Oct. 200	The adaptive fusion method is proposed for fire detection of firefighting robot
2	"Fire fighting robot" by S. Kannan, R. Karthikeyan, and S. Sathish Kumar, Chennai, MAY 2006.	Design a Fire fighting robot using embedded system
3	"Fire Fighting Robot" invented by Hadi A. Al-Azemi, Feb 26, 2013	This invention relates to a firefighting robot with a caterpillar drive assembly including a left and right drive unit and an engine for each drive unit.
4	"Fire Fighting Robot" Choong, Cheat Sun 2015-11.	This project mainly to portray basic function of a real big scale firefighting robot into a small-scale robot.
5	"Autonomous Fire Fighter Robot Using (IoT)" Dr. Satish Sankaye March 2018.	Robot built for detection and put of fire at the same time and can able to monitor by camera and send result by using Internet of Things (IoT)

Figure 1: Literature review

For many years robotics have become popular in many ways because of its variety of design and technological advancement. Our motivation to design a fire fighter robot is to help the community in effectively firefighting by sensing the fire and quickly acting without heavy losses of property or life. In some projects a tracking line is assigned for the robot to follow these paths to extinguish the fire. In some designs ultrasonic sensors are used. When it comes to simulation of this design it will make it difficult to implement it in real time situations. From the different projects reviewed, certain objectives helped us to choose a popular technique to fight fire efficiently by controlling it remotely by wireless technology application and using two main sensors as Flame Sensors and Ultrasonic Sensors due to their ability to detect fire and obstacles on the way and fire extinguisher pump to extinguish the fire.

III. SYSTEM ANALYSIS AND REQUIREMENTS

1) Software Specification –

- i. **Arduino-** Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. the Arduino IDE uses a simplified version of embedded C, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

2) Hardware Specification –

- i. **Arduino Uno** - The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo.
- ii. **Servo Motor** - A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.
- iii. **Flame Sensor** - Flame Detection Sensor Module is sensitive to the flame, but also can detect ordinary light. Usually used as a flame alarm. Detects a flame or a light source of a wavelength in the range of 760nm - 1100 nm. Detection point of about 60 degrees, particularly sensitive to the flame spectrum. Sensitivity is adjustable, stable performance.
- iv. **Battery** - The Arduino Uno is battery powered by making up a battery clip with connector. A battery clip is soldered to a 2.1mm barrel connector (centre positive). The battery holder with 6 cells will provide about 9V with ordinary 1.5V cells or about 7.2V with rechargeable cells.
- v. **Ultrasonic Sensor** - Ranging sensors include sensors that require no physical contact with the object being detected. They allow a robot to see an obstacle without actually having to come into contact with it. There are several methods used to allow a sensor to detect obstacles from a distance.
- vi. **Metal Chasis** - Powder coated Metal chasis for robots. Easy to mount the motors on place by using normal motor mount nut. It can either be used in skid steel configuration (4 motors) or differential configuration (2 rear wheels + 1 front castor wheel). The body contains perforated holes for easy mounting of various size circuit boards and other mechanical components.
- vii. **Water Pump** - A device that moves fluids is popularly known as water pump. Pumps serve a wide range of industries like aquarium filtering, pond filtering and aeration, pumping water from wells, car industry, energy industry, and medical industry. It is used here to take input water from the water storage to sprinkle it where the flame is detected.
- viii. **Circuit Components** - There are numerous basic electronic components that are used for building electronic circuits. Without these components, circuit designs are never complete or didn't function well. These components include resistors, diodes, capacitors, integrated circuit.

IV. ARCHITECTURAL DIAGRAM

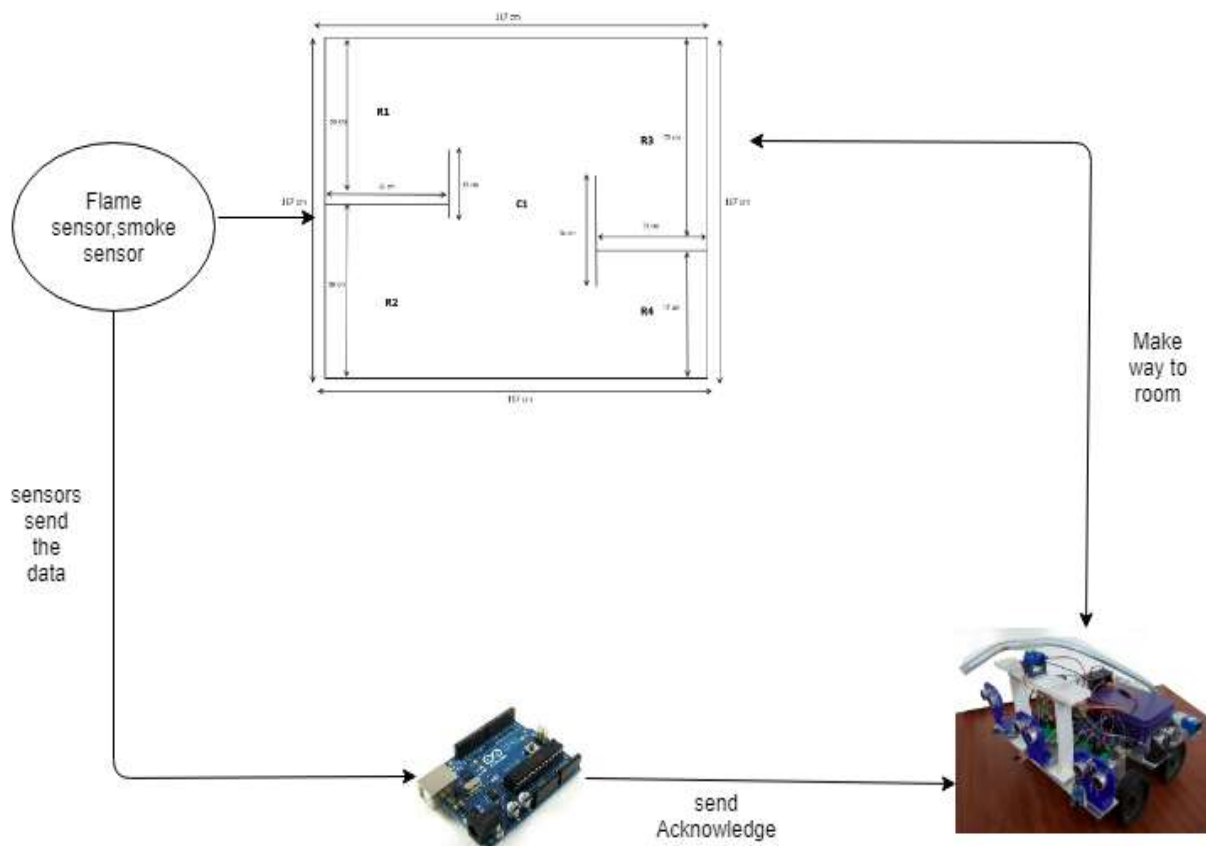


Figure 2 : Architectural Flow

The flow of the process can be depicted by the architectural diagram as shown in the above picture the flame sensors, smoke sensors and all equipments are connected to the rooms. The rooms are built for the demonstration purpose which makes the use of distances for navigation purposes. The sensors on the robot as well as the rooms send the data to the arduino which then triggers the robot to take actions and extinguish the fire by using fire extinguishment mechanism.

V. PROPOSED MECHANISM

Fabrication of the robot was found locally. It is the purpose of the design to demonstrate a fabrication process of Fire Extinguisher Robot that can perform safely.

Making of robot Platform - The base for the making of robot is made from Aluminium foil. It is light weight for withstanding the circuit component over it. The dimensions of the aluminium foil are 25 cm*25 cm. The thickness is 3mm. It provides more surface area, good strength and shock resistance capacity.

Water spreading Mechanism - The water container has the capacity to contain at least 0.5L water. It is made of plastic filaments through 3D printer which has water resistant property. A water sprinkler is used at the front of the pipe to spread the water. The use of the sprinkler reduces the velocity of water from the pump greatly but spreads the water effectively for extinguishment purpose.

Mobility of the Robot - This is a high functioning robot. For the proper mobility of the robot, 4 wheels are used 2 of which are of 3.5 cm and 2 of them are 4 cm. The motors' movement is controlled by a motor driver which responds to the signal from arduino. The motors have high torque and speed.

Making of the Room platform - The rooms are made by the use of PVC foam boards. It is a type of interlocking system.

VI. IMPLEMENTATION

The robot is tested on the made platform. Firstly, the room paths are initialized with coordinate values. The system then waits for the incoming data and after the data is received it selects the path depending on the incoming data then it searches for the value till the flame is detected. After, the detection of the flame, the sprinklers are activated which spreads the water over the area with the flames detected. Then after the extinguishment of the fire go reverse or to the home.

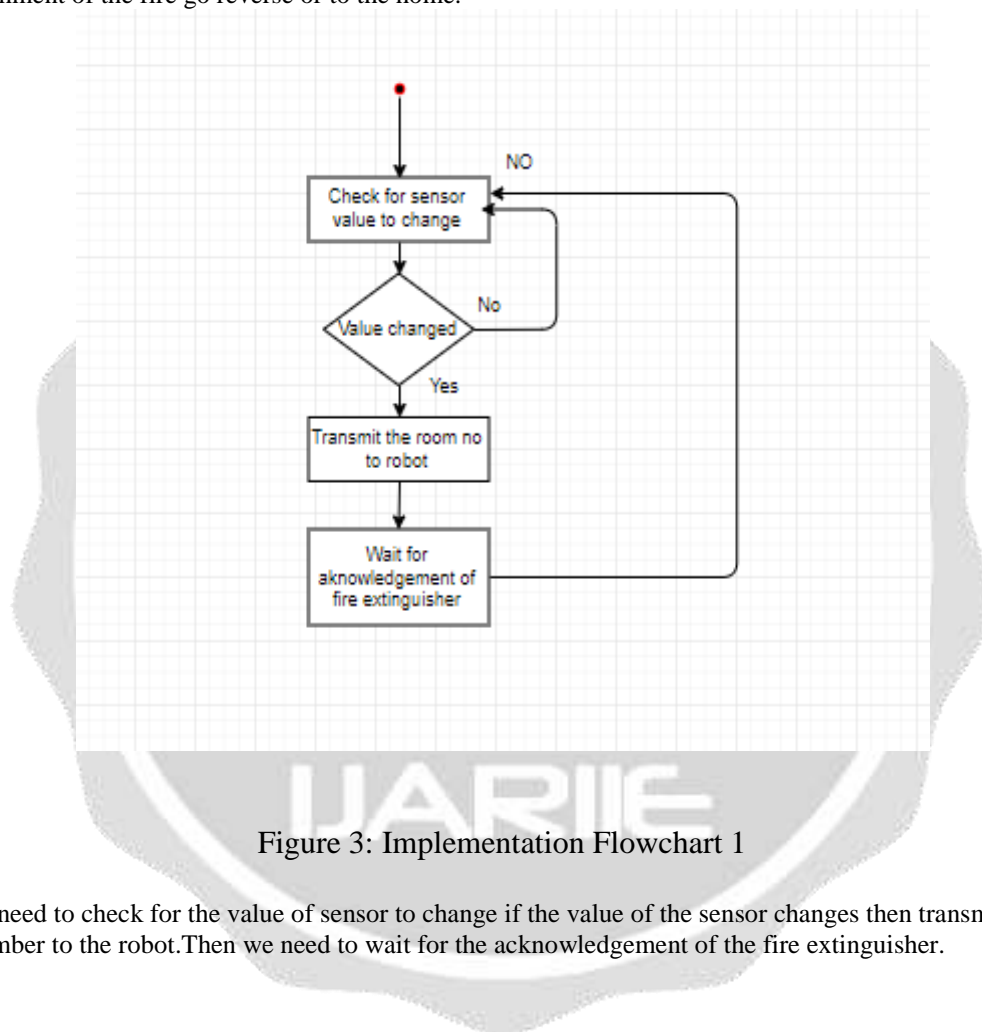


Figure 3: Implementation Flowchart 1

Here we need to check for the value of sensor to change if the value of the sensor changes then transmit the room number to the robot. Then we need to wait for the acknowledgement of the fire extinguisher.

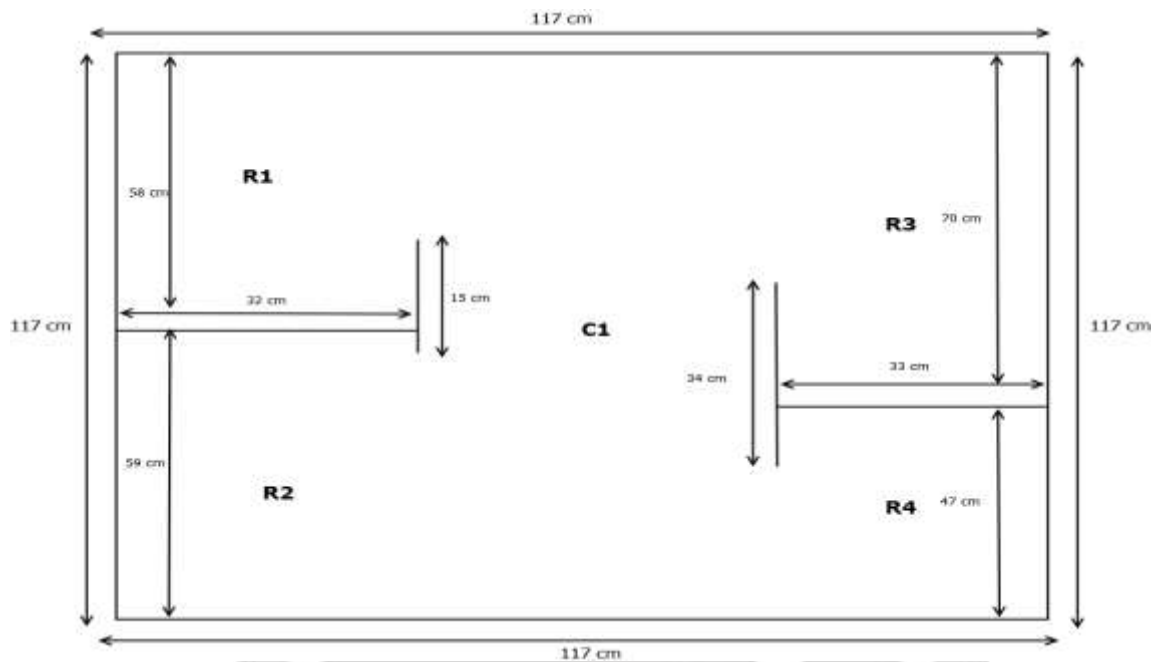


Figure 4: Arena for robot movement

Initially the robot is positioned at the root. One microcontroller is present to monitor the robot, transceiver is mounted on microcontroller which transfers the data from one point to another. There are several sensors deployed in each room R1, R2, R3, R4 and further these sensors are connected to the main controller. One transceiver is connected to the same controller to transfer further movement commands to the robot. The flame sensors sense and detect the flame. The sensors check for the value to get changed and then transfers the particular room no to the robot.

Here for navigation and movement purpose an array is used. The array consists of the path to the room. Before that the robot is in the waiting condition. It waits for any sort of acknowledgement from the main controller. With the help of the array the robot moves towards the room. For straight direction 0 is used. For left direction 1 is used and similarly for right direction 2 is used.

The walls, corridors and obstacles are detected with the help of ultrasonic sensors. The robot uses the array to reach to the point of particular room which has flame of fire in it. The robot then uses sprinklers to extinguish the fire.

After the complete extinguishment of the fire the robot will leave the room and will follow the reverse path to reach at the root position. Here now the first array with different assumptions is used to move in reverse order. Like it will use 0 for straight movement, 1 for right movement and 2 for left movement.

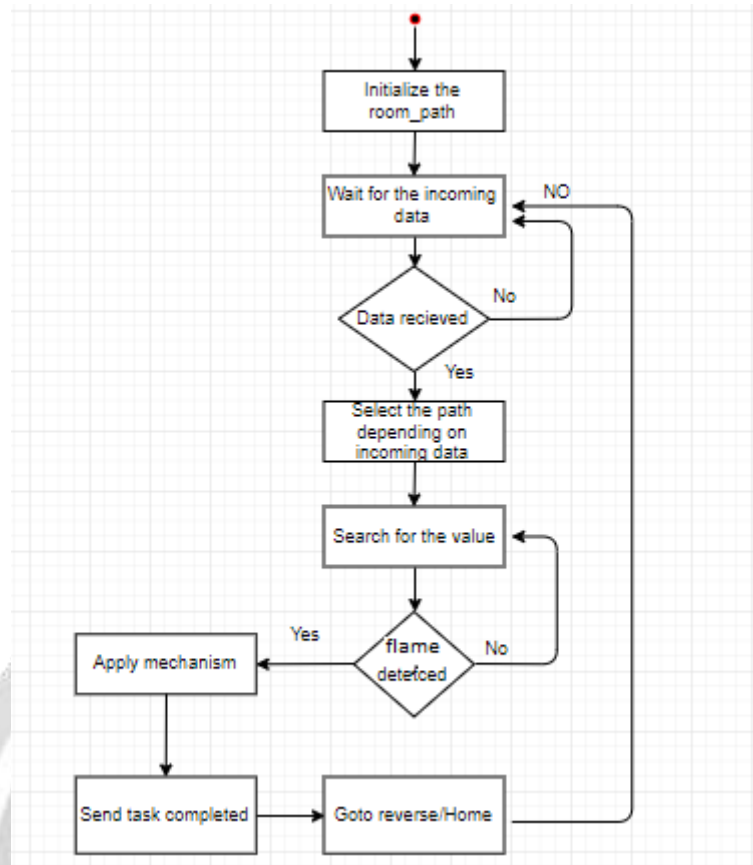


Figure 5: Implementation Flowchart 1

V. APPLICATIONS

1. The system can be used to detect flames of fire and extinguish it by using a water spary.
2. To extinguish fire in industry areas.
3. To replace fire fighter troops with automated fire fighter robot.

VI. CONCLUSION

Fire hazard is one of the dangerous problem faced today. It is not safe for firefighters to always endanger their lives. So we have designed and developed a Fire fighter robot. This robot can be used to extinguish fire for different types of industries. The robot is controlled by computer programming.

This paper describes the viability of simulation and animation of Fire Fighting Robot in order to evaluate the performance of the robot design in meeting some of the contest rules such as navigating in a labyrinth arena without hitting walls, quickly extinguishing a flame in a room.

This proposed system will replace the firefighters and help to extinguish fire using flame and obstacle sensors.

VII. FUTURE SCOPE

1. In upcoming years, we can incorporate image processing techniques to efficient images of fire, using hybrid techniques for the classification of data and lossless image techniques.
2. We can make the made robot adaptable to move over staircases.
3. Incorporation of fire extinguishers are to be made.
4. The robot can be programmed to work on priority basis wherein more importance will be given to the area that contains more human lives according to the priority parameters.

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