Wi-Fi Based Fire Extinguisher Robot

Abul Hassan Laiq¹, Bheem Kant Kaushal², Mohan Kumar³ and Chandan Choubey⁴

¹,²,³,⁴Department of Electrical and Electronics Engineering, Dronacharya Group of Institutions, Greater Noida

hassanlaiq100@gmail.com¹, bheemkantkaushal@gmail.com², mohankumar24115@gmail.com³, er.choubey.chandan@gmail.com⁴

Abstract: Fire occurrences are the disaster that can cause many humans as well as animal death, property mutilation and disabilities to affected humans. The main motive to develop this robot is to overcome the loss of human lives and get best of this disaster. The idea is to develop a robot that will be used for fire extinguishing purpose and save a huge number of human lives. Keeping in mind that the human and animal lives are important to work upon. A low-cost robot will be developed for fire extinguisher. Arduino programming will be done wisely so that the flame sensor can work accordingly. Small and low-cost robot will definitely reduce the chances of fire to get to its extreme level.

Keywords: Fire Extinguisher Robot, Flame Detection, Wi-Fi Controlled, Arduino UNO R3.

1. Introduction

Many fire disasters occur all over the world which results in high losses of building, factories etc. Many of the time the fire is uncontrollable in buildings and many other places due to less sources. It’s hard to access the internal building rooms for fire fighters due to high temperature. There must also be many explosive materials which may results in large scale complications. According to reports over 1.6 million fire incidents occurs which results in 27,027 deaths. Looking at these problems faced by Indian fire fighter we’ve proposed our paper in which the robot is used to extinguish the fire by entering various buildings through a distance in order to reduce risk. The movements are controlled through smartphone via Node MCU ESP8266. The 12V water pump is used as an extinguisher to extinguish the fire which is in direct phase with the battery. We’ve used Arduino Uno R3 which is connected with flame sensor to sense the fire by emission of visible UV and IR radiation. L298N driver IC is used for the movement of the motors commanding to move forward, backward, left, right and stop. The robot was equipped by 12V Battery and regulating 5V supply and producing 5V to Arduino and an onboard LED. In the fire examination, the robot can perform the task of fire extinguishing properly.

2. Literature Survey

(Sampath, 2011)[1] developed a robot which features was to move in the direction with respect to the fire intensity. (shah, shah, mantora, & hapani, 2013)[2] developed a robot to autonomously navigate fire while actively scanning of flame. (Sirega, Purba, & Fahmi, 2017)[3] developed a robot which was controlled by using smartphone via Wi-Fi network utilizing Wi-Fi module contained in the robot. (Rashid, Ahmed, ullah, newaz, & mohmmad, 2016, pp. 41-46) [4] developed a fire extinguisher robot which was operated in multiple modes using DTMF and Bluetooth remote control as well as GSM and
GPS technology. (latif, shankar, & nguyen, 2020)[5] developed a fire fighting robot using PID which was processed in a microcontroller. (prasoji, nguyen, & shahu, 2020)[6] developed a robot to extinguish fire by using a robot which was controlled using AT89S52. (Suresh, 2017)[7] developed a robot for detecting flames indoors and extinguish it with the help of CO2. (preetidhiman, nagar, singh, & kaushik, 2013)[8] developed a robot which was controlled through connected speech input. (singh, Mahajan, sukavanam, budhraja, & singh, 2015)[9] developed a robot which extinguish fire using DC water pump and a water container using 5 infrared sensors. (raju, mohammed, paul, john, & s, 2017)[10] developed a robot controlled and monitored by Arduino UNO microcontroller. (taha & marhoon, 2018) [11] developed a robot which was used for extinguish fire in general and in closed area for protecting employees in the field of fire.

3. Design Methodology

Figure 1 shows the block diagram of Wireless Based Fire Extinguisher Robot. The basic proposal of this robot in the paper is to sense the fire and extinguish it with the help of 12V water pump by entering a several rooms in the building which are caught by fire and unreachable by fire fighters. Arduino Uno R3 interfaced with Servo Motor, Flame Sensor and Buzzer to notify the fire Thus, the fire sensing is performed.

![Image](image_url)

**Figure 1.** Design Methodology of Fire Extinguisher Robot (Real Image)

According to Principle of Flame Detection, the penetrating reaction is given by the emission of visible UV and IR radiation. Fire usually occurs due to the chemical reaction in which materials combines with oxygen and heat is generated. So, the fire extinguisher works on the principle of cutting off the source of oxygen to the fire and control the temperature. The major advantage of this robot is to help fire fighter to extinguish the internal space where the fire fighters are unable to access. The motors will be of low RPM so that they will have a high torque to climb a stair even in worse situations. The robot can be easily accessible through an android application which will work through Wi-Fi technology.
Here if the robot is going in any direction whether forward, backward, front and back, and fire occurs the robot will sense the fire through Flame sensor and will stop. Then after the robot will sprinkle water to extinguish the fire through android application and alarm will be turned ON to alert all nearby people and robot will stop.

4. Elements: The elements that are involved in the prototype model are discussed below.

4.1 Arduino Uno R3

Arduino uno is used for several purpose in electronic circuit because it’s cheap and can be programmed for any use. Arduino is usually used for robotics purpose. For E.g. Arduino is used in Drone and remote-control car. Nowadays Arduino is widely used in Home Automation System.
4.1.1 Arduino consists: Data transport port which can either be connected through laptop or OTG. Basically, Data transport port is used to install the program from laptop to the Arduino. If Arduino is connected to laptop or smartphone then Arduino doesn’t require any external supply, it automatically generate 5V from laptop or smartphone.

For giving power supply an input port is present. In this port we can give supply of 5V up to 12V.

Microcontroller is the main part of the Arduino Board. It can also be called as the Brain of the Arduino Board. Microcontroller is used to store the program. It consists of 28 pins. Among 28 pins the 14 pins are called the digital I/O pins which are categorized in 2 parts where 6 pins are analog pins and another 6 pins are PWM (Pulse Width Modulation) pins. In this chip the operating voltage is 5V and its input output pin consists of 40mA current while flash memory is of 32KB. Its static RAM is 2KB and its EEPROM (Electrical Erasable Program Read Only Memory). The clock speed is 16 MHz

Reset Button in an Arduino is used to reset the program which is running in the microcontroller to its initial stage.

4.1.2 There are different types of pins in an Arduino:

- Power Pin: - This pin consists of IOREF (input output refresh pin), Reset Pin, 3.3 and 5V pin, GND, V input pin.
- Analog Pin: - This pin has 6 I/O pins. It works as an analog sensor such as humidity sensor, Temperature sensor and reads its signal and converts the signal to digital form then microcontroller read the digital value.
- ICSP (In Circuit Serial Programming): - It used to program Arduino.
- Digital Pin: - This pin is used as a digital input as well as for digital output.
- ARP (Analog Refresh Pin): - Its generally use for external Reference Voltage. (0-5V)

Arduino in this project is used to interface and program the sensor as well as to command the Buzzer to tone after detecting Fire.

4.2 Flame Sensor

Flame Sensor by its name can be easily described that it senses the flame. When the fire occurs, it generates heat in IR form which is detected by the IR receiver. Flame sensor consists of 4 Pins which basically is used as Analog output and Digital output. The main difference between analog output and digital output is to give continuous stream of information or command for fire or no fire. Potentiometer is present in the flame sensor to change the sensitivity of IR receiver. As shown in fig 3, there are 2 LED where the 1st LED works when the Flame sensor is turned ON and the 2nd LED works when IR sensor detects fire. The wavelength ranges from 760mm to 1100mm. It detects the fire and stop the robot to sprinkle water on it. With the help of IR radiation the flame sensor detects the fire.
4.2.1 Working of Flame Sensor:

- It uses IR flame flicker techniques to detect the flame or fire through its humidity.
- The IR detectors detects only low frequency flickering IR radiation.
- The sensor has a photodiode which is an IR receiver, capacitor, potentiometer, LM393 and a resistor.
- The sensitivity can be varied by varying onboard potentiometer.
- Working voltage of flame sensor is 3.3V and 5V.
- If the logic is high the output indicates presence of fire and flame, if it is low the output indicates the fire absent.

4.2.2 Application of Flame Sensor in Robot:

- Fire Alarm
- Fire detection and stop the robot
- Sprinkle water at the desired distance using servo motor.

4.2.3 Features of Flame Sensor:

- Wavelength: 760mm-1100mm
- Detection range: Upto 50cm
- Angle: 60 degrees
- Operating Voltage: 3.3V-5V
- Digital and Analog Output
- Power indicator and digital switch output indicator.

4.3 NodeMCU ESP8266 Module

NodeMCU ESP8266 is a Wi-Fi module through which we can connected any Wi-Fi network by use of microcontroller. Through ESP8266 we can transfer data to any website and we can receive data from a website. We can communicate microcontroller with another microcontroller via Wi-Fi. For E.g., Nowadays home automation is done through wifi connected to an android mobile which can turn ON and OFF through Mobile via Wi-Fi.
In this module we can find an indicator which indicate the ESP and the other indicator is used to indicate Load. L298N motor driver and Relay is connected to the NodeMCU to drive the BO gear motors as well as for sprinkling the water by use of DC water pump.

4.4 Servo Motor

We all have notice robotic arm which are used for packaging etc. in factories which works precisely or solar panel and dish antenna which moves according to direction of satellite or sun, so to perform particular task, particular important motor is used i.e., Servo Motors. Servo motor is assembled on top of the robot to rotate the pipe 360 degree for extinguishing of robot.

4.4.1 There are mainly 2 Types of Servo Motors:
- Rotary Actuator
- Linear Actuator

Rotary actuator moves in circular form. There are 2 types of Rotary Actuator:
- 180 Degree Rotary Actuator
- 360 Degree Rotary Actuator

While Linear Actuator is used as a push and pull motor. These types of motors work precisely to hold and an object by servo motor to the destined place. The very important feature of this motor is to control the distance and angle precisely. We can control speed, but it’s difficult to
control angle and distance, by using servo motors it’s easily possible to control the angle and distance.

4.4.2 Selection of Servo Motors: In our innovation it is required to have a 360-degree rotation to cover the whole area by using servo motor. So it is necessary to have a 360-degree rotary servo motor which can handle the actuator weight

4.5 L293D Motor Driver

Basically, we use the motor driver to drive the motors in embedded projects or for a robotics project. A BO motor cannot be driven with using only IC (Integrated Circuit) as IC doesn’t have the power to run a motor. So, for that we normally use a Motor Drivers like L293D.

![L293D Motor Driver](image)

**Figure 7.** L293D Motor Driver [12]

4.5.1 Specification of Pins

- Pins 1 and 9 is the Enable pin. When 5V is given to enable 1, All the pins on left side gets activated and while when connected high voltage to enable 2 (5V) the right side gets activated.
- Pin no. 2,7,15 and 10 acts as an input pin.
- Pin no. 3,6,14 and 11 acts as an output pin.
- Pin no. 4,5,12 and 13 are always be grounded.
- Pin no. 8 is the pin which have to be given voltage to run the motor.
- Pin no. 16 is the pin to power to the IC (5V).

Basically, when giving two different power supply for e.g. separate power supply to a microcontroller and other power supply to L293D, we make sure to make the ground common.

4.5.2 Working of L293D Motor Driver: If a motor is connected to the right side of the motor driver, so Pin no. 14 and 11 should be connected to the motor. Where pin no. 10 and 15 acts as an input. So, pin no 10 and 15 should be connected to another microcontroller.

When pin number 2 of L293D is 1 and pin no. 7 is 0, so the motor which is connected to pin no 3 and 6 will rotate in clockwise wise direction. And when pin no. 7 is 1 and pin no. 2 is 0 it rotates in anti-clockwise direction.

Similarly, when pin no. 15 is 1 and pin no.10 is 0, the motor which is connected to pin no.14 and 11 will rotate the motor in clockwise direction, while the polarities is changes the motor rotates in anti-clockwise direction.
This is how a L293D works. So, the motors can be rotated in both the directions. Also, if we want both the motors to rotate in the same directions, short circuit the pin no. 3, 6, 14 and 11 together.

4.6 Battery Operated (BO) Geared Motor
It consists of specification and interfacing of BO gear motor.

4.6.1 Specifications of BO Gear Motor
- It operates at 3-12V DC
- These motors have current specified by the load on the shaft. The bigger the load the more the current must take from the power source.
- All gear motors come with a specification of gear ratio.
- Brush motor attach this gear have a 17000RPM at 6V. When, 17000RPM/48 = 354RPM. So, the speed decrease to around 6 rotations per second.
- While speed decreases Torque increases (Maximum Torque: 800gf cm min 3V)
- They do not care about polarities, so it can be changed easily.

![BO Gear Motors (Real Image)](image)

4.6.2 Interfacing BO motors with Arduino: First, we connect motors with motor drivers as brushed motors don’t care about polarities. After uploading code in Arduino then we connect the Motor driver middle terminal to Arduino ground and motor. Driver terminal right of 5V Arduino. These two connections are made so that we can power up the Arduino after we’ve uploaded the code and connected the battery as shown in fig 18

4.7 Mini Submersible Water Pump
A Mini water pump is extensively used in aquarium, bathing, household items etc. A mini water uses the principle of motor. A motor rotates and push water outside of the pump.

![Water Pump (Real Image)](image)
4.7.1 Specifications of Mini Water Pump:
- Its light weighted which is easy to use.
- Small in size
- Low power Consumption
- A little noise

4.7.2 Advantages of Mini Water Pump:
- After submerging in water, the water absorbs its noise which make its low noise.
- Mini water pump is very effective as less power is consumed.
- Structure is small and is easy to implement.

4.7.3 Working of Mini Water Pump: Mini water pumps are generally used in household equipment. Owing to minor in size and weight, minor DC motors are coupled with water pump. While this DC motor is attached to the impeller. Motor consist of a stator and a rotor with coil. Around the coil a magnetic field is produced that flow through the rotor and making the rotor to move 180 degrees. When the rotor moves the electricity in coil of Somerset, pushing the rotor again. After many pushes, the rotor continuously spins and initiate the impeller to power they pump

5. Result and Discussions

After making all possible connections and calculations we have reached to a final result, our project is capable of extinguishing fire by entering inside a building by using Flame sensor to detect the fire by its UV and IR radiation and extinguish the fire using water pump as an actuator which is operated through android application. After many hitches it has been implemented to detect a fire from a particular distance. It has numerous advantages as it can be controlled through Wi-Fi from a far distance. It can save many lives which are loss by the fire at buildings, factories, power plant etc. The robot can enter small places and small spaces which is a major advantage. Inbuilt of camera can actually help us monitor the fire and stop the robot accordingly to extinguish the fire. As a conclusion the project of evolving the Wi-Fi based fire extinguisher Robot has reached its aim and objective. The comparison of the proposed work is done with the existing model in the below table 1.

| Existing model                  | Proposed Work                                      |
|--------------------------------|----------------------------------------------------|
| Not very efficient             | Very efficient                                     |
| Cost is high                   | Cost is very low                                   |
| High maintenance charge        | Low maintenance charge                             |
| High-cost materials are used   | Low-cost materials are used                        |
| Complex use                    | Easy to use through Android Mobile via Wi-Fi       |
| High Noise                     | Low Noise                                          |
| Low Accuracy                   | High Accuracy                                      |
| Pump operations is automatic   | Pump operation can be controlled through Wi-Fi     |
| Vibration is high              | Vibration is negotiable                            |

The final project (working model) hardware is displayed in the below figure 10.
6. Conclusion

Hence the objective is to create a model which helps the citizens to extinguish the fire in their places with the help of Wi-Fi technology which is also easy to use and low cost. It works when it detects the fire and an alarm sound is created to alert all nearby people to know the recent position of their respective place. It’ll surely reduces the loss of lives by fire in malls, building, colleges, and school etc. reducing major threats in our country.

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