Smart Sensor Network-Based Autonomous Fire Extinguish Robot Using IoT

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Abstract—Fire explosion is among the main reasons for death in the world. The urban spaces have a lot of population, many systems have control over fire detection but not over control of fire due to lack of functionalities. The operation of the robot depends on the android application on the smartphone. It can also be communicated using Wireless fidelity technology. The motion detection technology is embedded in it, which can identify the objects or obstacles. With Arduino microcontroller and IoT technology, this robot can send emergency alerts in critical conditions, explore the compounds, and effectively check for the fire. The entire robot was contained in the sensor-based network, and if the sensors fail to detect, the robot still will operate and extinguish the fire with the help of an inbuilt camera. Finally, this robot is tested for operation in automated mode and live video buffering capability.

Keywords—Arduino, camera, sensor, IoT, Robot

1 Introduction

Many people work in a preserved environment in day-to-day life, many organizations and many more families face the hazardous fire. It is directly related to health loss and property loss; thus, fire detection systems are essential. Not useful in most situations. The motion control in robotics is divided into sensor-based and vision-based technologies [1]. The intelligent home-based fire detection system is explained [2]. The advanced security-based robot is designed in the United Kingdom with high fire extinguishing properties [3]. The intelligent multi-sensor-based security system for firefighting robot is developed [4]. The same PID Controller is used in a robotic system, which adjusts dynamically to the errors and the size and weight of robots in present conditions [5]. The image processing algorithms and device controlling algorithms are used to detect the Fire [6]. The safety of railways and road tunnels is broadly explained

in robotic systems and significant infrastructures [7]. The detection of candle fame with sensors' help and extinguish the fire are presented with design [8]. Dangerous gases like carbon dioxide and nitrogenous oxide can be detected in spaces hidden from extinguishers [9]. The obstacle detection and avoidance are explained using ultrasonic sensors in large fire fields where high-temperature situations, anti-jamming processing are designed [10]. The PID controller-based backpropagation neural networks is proposed to adjust the error rate parameters in the real-time robot controller [11]. The industrial robots are designed with specific materials, divisions, gadgets [12]. Following the Fourth Industrial Revolution (4IR), there is interest in one framework that can control, convey, and coordinate various robots paying little heed to their sorts and determinations [13]. The robot can be isolated into a few gatherings, for example, Tele-robots, Telepresence robots, Mobile robots, Autonomous Robots, and Androids robots. [14]. A versatile robot is intended to explore and do undertakings with the mediation of people [15]. In the interim, self-governing robots can autonomously play out the performance and get the earth's force, instead of android robots that are worked to impersonate people [16]. The smart sensor network is designed for air pollution monitoring [20], temperature monitoring in VI server [17], fire rescue system [18], atm management [19], the UAV designed is used for sowing seeds are taken as a reference [20].

2   The Proposed System

The proposed robot will able to receive commands and react according to that in manual mode. The authorities may be timed or done manually. This smart robot can be connected with a remote using the help of Wi-Fi. An android app is developed to control the functionalities of the robot. Our robot has a unique function to detect the quantity of coolant present as backup whenever the coolant pressure is low; it sends an alert message to the mobile application. It uses the flame sensor for detection. The robot can move while also scanning for obstacles, which might turn out to be dangerous, sensors perform this scanning, robots helping as firefighters have not been implemented, and dedicated equipment that can already be used for such applications. Our robot can be sent into the danger zone to scan and extinguish.
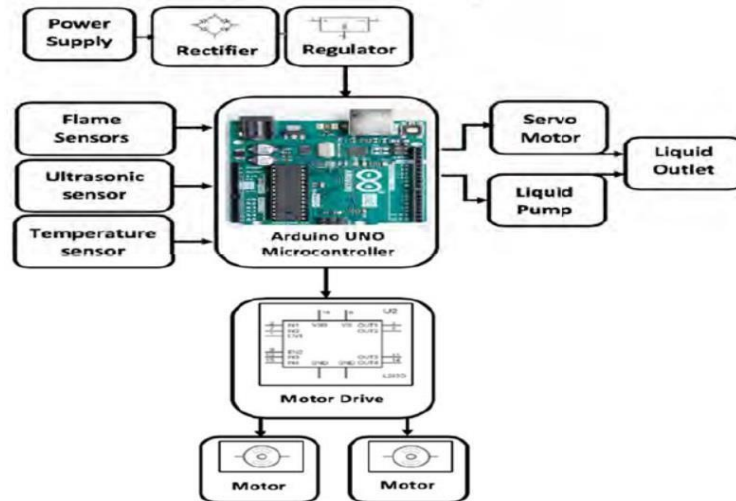
Fig. 1. Block diagram of the proposed system

Larger bots can be sent with more coolant capacity in them. The robot is implemented in situations where it is hazardous for firefighters to enter. It can detect the fire, and it can maneuver accordingly. It can detect and avoid obstacles autonomously. It regularly takes images of the danger zone at intervals, and it forwards the images to the controller. The android app is easy to use and is thus user friendly. In this system, the methodology has three parts. All parts were combined to obtain the function of fire detection, controlling it by extinguisher and gaining knowledge of the robot's behavior. Part one is the mechanical structure design of the robot's body. Part two is the implementation of the hardware parts used, and the third one is the design of the software and its details. Several electronic components are used to develop this: sensors, DC motors, Motor Driver L293D, servo motors, and pump with Arduino UNO, flame sensor, ultrasonic sensor, temperature sensor, and pump for pumping the liquid which is inside the tank.

The explainable diagram is shown in figure 1 below. Functional Requirements: Robot Automation Description and Priority Predictions will be made based on the sensors' data. These predictions will give the user the idea to turn the Motor on through the android application and without human intervention. The highest priority is given to automation. Response Sequences According to the obstacle detection, the fireman will decide whether to turn the robot to the left or right. As obstacles will be detected, the robot will function accordingly. If the fire is detected, the microcontroller will send a command to the sprinkler for turning it on. Then splinter will sprinkle water to extinguish the fire.
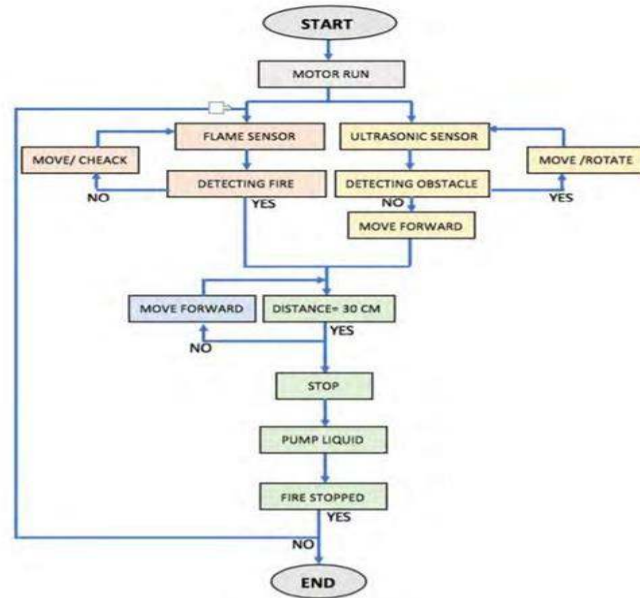
Fig. 2. Flow chart of the proposed system

3 Implementation

The procedure is described in the flow diagram shown in figure 2. if temperature sensors are added, more accurate results can be achieved from the incident. All these sensors are connected to an Arduino UNO and the pump with motors used to control the robot's 360-degree rotation. If the fire's flame sensor detects the fire, the Motor will stop at 35cm away from the fire and start to flush and push the fluid towards the fire source noticed.

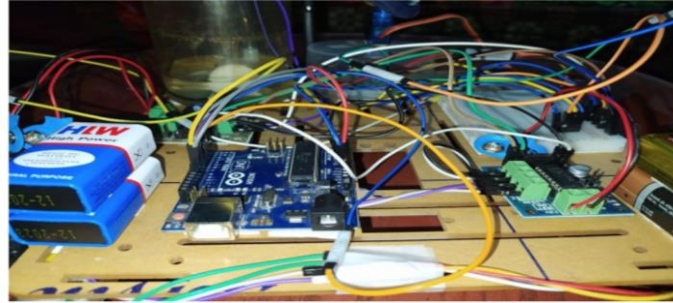**Fig. 3.** Side View of Fire Fighting robot

Fig. 4. Top View of Fire Fighting robot

3.1 Programming

Programming is the core element in building an autonomous robot that can make its own decisions using sensors as feedback.

Put off Fire:
```
void put_off_fire()
{
delay (500);
digitalWrite(LM1, HIGH); left motor1
digitalWrite(LM2, HIGH); left motor2
digitalWrite(RM1, HIGH); right motor1
digitalWrite(RM2, HIGH); right motor2
digitalWrite(pump, HIGH); delay(500);
for (pos = 50; pos <= 130; pos += 1) {
myservo.write(pos);
delay(10);
}
for (pos = 130; pos >= 50; pos -= 1) {
myservo.write(pos);
delay(10);
}
digitalWrite(pump,LOW);
myservo.write(90);
fire=false;
}
```

3.2 Unit testing

Unit testing is a typical practice in programming improvement where you fundamentally test code units to watch that they function true to form. Those units are standard techniques for your code, unmistakably worked in a specific assignment, such as playing out a particular estimation or parsing info. Your test code will, at that point, pressure

that strategy with various data sources and check if the yield coordinates the usual worth.

Table 1. Video Feed Test

Test Case #	1
Test Case Name	Video Feed Test
Description	To test if the camera is taking in capturing the video through the application
Expected Output	Video feed visible in the android app
Actual Output	Video feed visible in the android app
Remarks	Pass

Table 2. Bluetooth Module Test

Test Case #	2
Test Case Name	Bluetooth Module Test
Description	To test if the Bluetooth module is taking in the input from the application by connecting the phone to the device
Expected Output	Successfully connecting
Actual Output	Successfully connecting
Remarks	Pass

Table 3. Motor Test

Test Case #	3
Test Case Name	Motor Test
Description	To test if the Motor after connected to the Arduino and power supply
Expected Output	Successfully working
Actual Output	Successfully working
Remarks	Pass

3.3 Integration testing

Table 4. Video Stream Test

Test Case #	4
Test Case Name	Video Streaming Test
Description	To test, the android application can take in the connect with the second phone through the hotspot
Expected Output	Successfully connecting
Actual Output	Successfully connecting
Remarks	Pass

Table 5. Controlling the Motor using the Bluetooth Input

Test Case #	5
Test Case Name	Controlling the Motor using the Bluetooth Input
Description	The Android application sends a command to the Bluetooth module, which makes the Motor Spin
Expected Output	Successfully Spinning all 4 motors
Actual Output	Successfully Spinning all 4 motors
Remarks	Pass

Table 6. Controlling the movement of the Bot

Test Case #	6
Test Case Name	Controlling the movement of the Bot
Description	Using the application to move the bot after attaching the wheels on the Motor
Expected Output	Successfully Spinning all 4 wheels
Actual Output	Successfully Spinning all 4 wheels
Remarks	Pass

Table 7. Controlling the direction of the Bot

Test Case #	7
Test Case Name	Controlling the direction of the Bot
Description	Using the application to move the bot to the desired direction
Expected Output	Direction Changed
Actual Output	Direction Changed
Remarks	Pass

Table 8. Detecting the fire using the IR Sensor

Test Case #	8
Test Case Name	Detecting the fire using the IR Sensor
Description	Testing if the IR sensor can notify the application about the fire
Expected Output	Notification Received
Actual Output	Notification Received
Remarks	Pass

Table 9. Liquid Release mechanism

Test Case #	9
Test Case Name	Liquid Release mechanism
Description	Using the Application to Douse the Fire using the spray
Expected Output	Spray successfully Released
Actual Output	Spray successfully Released
Remarks	Pass

4 Conclusion

Firefighters are courageous and risk their lives whenever a fire occurs. Our robot will bring down the fires by going into the Fire hazardous zones remotely, controlled,

or autonomously, thereby reducing firefighters' risk. Environmental awareness is a crucial aspect of this project, and our robot was made with that in mind. Our robot detects, avoids, and douses the fires around it with its many temperatures and proximity sensors. With its image processing capabilities, the robot can identify and avoid any obstacles that may be in the way of its objective to douse the fires. The overall total costing for the project will be of 63 US Dollars around. It can be used in places with the small entrance or small gaps because it's a compact structure.

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