T.E. Project Synopsis

on

(Fire Fighting Robot)

T.E. Project Stage

Submitted in partial fulfillment of the requirement of

University of Mumbai

for the Degree of

Bachelor of Engineering

(Electronics and Telecommunication)

by

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(2022-23)

CERTIFICATE

This is to certify that the project entitled

<u>"Fire Fighting Robot"</u>

is a bonafide work of

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Name of guide & Sign: ………………………….

Head of Department

Principal

Date:
Place:

Project Report Approval for S. E.

This project report entitled of project **Fire Fighting Robot** by

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Examiners

1.________________________________

2.________________________________

Date:
Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Fire-fighting robots represent a significant innovation in the realm of fire suppression, offering the potential to mitigate risks and enhance the efficiency of firefighting operations. This abstract provides a concise overview of the development and implementation of an autonomous fire-fighting robot. The robot is equipped with advanced sensors for fire detection, navigation systems for precise movement, and fire suppression mechanisms for extinguishing fires. It is controlled by a central microcontroller, and communication is established through secure protocols for remote operation. Safety features and regulatory compliance are paramount, ensuring the well-being of both the robot and human operators. Real-world deployments and case studies showcase the robot's effectiveness in various firefighting scenarios. By combining state-of-the-art technology with innovative design, fire-fighting robots offer a promising solution for addressing fires in hazardous and challenging environments. This abstract underscores the significance of these robotic systems in advancing firefighting capabilities and underscores the need for ongoing research and development in this critical field.

INTRODUCTION

Firefighting and rescuing the victims is a risky task. Fire Fighters have to face dangerous situations while extinguishing the fire. Fire Fighters extinguish fires in tall buildings, drag heavy hoses, climb high ladders, and carry victims from one building to another. In addition to long and irregular working hours, fire fighters also face unfriendly environments like high temperature, dust and low humidity. Besides, they also have to face life-threatening situations like explosion and collapse buildings. According to the report of IAFF in the year 2000, 1.9 fire fighters per 100,000 structure fires have lost their lives per year in USA. However, this rate was increasing to 3 per 100,000 structure fires.

The different causes of Line Of Duty Deaths (LODD) are smoke inhalation, burns, crushing injuries and related trauma. Statistics shows that the deaths of fire fighters are constant every year. This results in need of firefighting machines to assist the fire fighters to avoid deaths by handling the dangerous situations. So if a robot is used instead, which can be controlled from a distance or which can perform actions intelligently by itself, which will reduce the risk of this task of fire fighting.

Robot is a mechanical device that is used for performing tasks that includes high risk like fire fighting. There are many types of robots like fixed base robot, mobile robot, underwater robot, humanoid robot, space robot, medicines robot etc. Fixed base robot has limited workspace due to their structure. A fire fighting robot will decrease the need of fire fighters to get into dangerous situations. Further the robot will reduce the load of firefighters. It is impossible to extinguish fire and rescue many victims at a time of huge disaster. Robot technology can be very efficiently used in such cases to rescue much more victims.

Thus robotics makes human life easier and safe as well as save a lot of time. The rapid development in technology improves the tools and equipments used in firefighting. These advance tools and equipments can be more effective and efficient. Moreover, it reduces minimum risk level. This will also reduce the damages caused due to an fire incident.

Literature Survey

A literature survey on fire-fighting robots is a comprehensive exploration of research, developments, challenges, and advancements in the field of robotics designed for fire suppression. It involves an in-depth examination of a wide array of topics. These include fire detection and sensing technologies like flame sensors, thermal imaging, and gas detectors, along with cutting-edge algorithms for enhanced accuracy in early fire detection.

Mobility and navigation systems, ranging from wheeled to legged platforms, are explored, with a focus on path planning, obstacle avoidance, and autonomous firefighting strategies. Fire suppression mechanisms, encompassing water cannons, foam dispensers, and robotic arms with extinguishers, are reviewed for their effectiveness in tackling different fire types. Control systems that manage the robot's movements, process sensor data, and enable autonomous decision-making are assessed, often incorporating machine learning and artificial intelligence.

Communication protocols for remote control and real-time monitoring, safety measures to protect the robot and operators, regulatory compliance, cost-effectiveness analyses, and emerging technologies such as swarm robotics and IoT integration all play a role in the literature survey. Real-world case studies and deployments shed light on practical challenges and successes in fire-fighting robot implementation. This extensive survey equips researchers and engineers with the knowledge needed to advance the development and utilization of fire-fighting robots in critical firefighting scenarios.

Methodology

Developing a fire-fighting robot involves a structured methodology to ensure its effectiveness in combating fires. Initially, it's crucial to define clear objectives and requirements, specifying the types of fires the robot will handle and its operating environment. Extensive research and planning follow, studying existing technologies and pinpointing the robot's specifications. Next, choose the appropriate mobility platform and integrate fire detection systems for accurate source location. Implement a fire suppression mechanism, decide on a power source, and develop a robust control system for navigation and obstacle avoidance. Secure reliable communication capabilities for remote operation and feedback. Safety measures, testing, and firefighter training are pivotal before deployment, with a focus on regulatory compliance. Continuous maintenance and data collection for performance analysis are essential for ongoing improvement. Ultimately, assessing cost-effectiveness compared to traditional firefighting methods will provide valuable insights into the robot's efficiency, ensuring it remains a viable and essential tool in firefighting operations.

Hardware Components

1. Flame Sensor
2. Micro Servo Motor
3. Single Shaft Motor
4. USB to Serial Adapter
5. Mini Water Pump
6. Relay Module
7. L298N Motor Driver Module
8. Jumper Wire
9. Rubber Wheel
10. NodeMCU

SOFTWARE USE:

1. Ardunio IDE
2. C-Programming
3. Mlx90614 library

1. Flame Sensor:

A sensor which is most sensitive to a normal light is known as a flame sensor. That's why this sensor module is used in flame alarms. This sensor detects flame otherwise wavelength within the range of 760 nm – 1100 nm from the light source. This sensor can be easily damaged to high temperature. So this sensor can be placed at a certain distance from the flame. The flame detection can be done from a 100cm distance and the detection angle will be 600.

2. Micro Servo Motor:

SG90 is a popular micro servo motor commonly used in hobbyist and DIY projects. It is a small, low-cost servo motor that can rotate 180 degrees with a maximum torque of 1.8 kg-cm. It operates at 4.8-6V and has a weight of approximately 9 grams, making it ideal for small-scale robotics and model control applications.

3. Single Shaft Motor:

The 300 RPM Single Shaft BO Motor - Straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors.

Small shaft with matching wheels gives an optimized design for your application or robot. Mounting holes on the body & light weight makes it suitable for in-circuit placement. This motor can be used with 69mm Diameter Wheel for Plastic Gear Motors.

It is an alternative to our metal gear DC motors. It comes with an operating voltage of 3-12V and is perfect for building small and medium robots.

The motor is ideal for DIY enthusiasts. This motor set is inexpensive, small, easy to install, and ideally suited for use in a mobile robot car. They are commonly used in our 2WD platforms.

4. USB to Serial Adapter:

TheFT232RL Breakout Board Mini USB to TTL Converter is a great TTL converter for board compatible with Arduino. It uses a chipset Ft232rl USB power which has over current protection. It uses 500ma Self-Restore Fuse and is integrated with Rxd/Txd Transceiver Communication Indicator.

The FTDI FT232RL features fully integrated USB terminator. Fully integrated clock generation that does not require an external crystal, plus optional clock output selection that allows seamless interfacing to an external MCU or FPGA. Data transfer rate from 300 baud to 3 Mbaud (RS422, RS485, RS232) at TTL level. A 128-byte receive buffer and a 256-byte transmit buffer (with buffer smoothing technology) provide high data throughput.

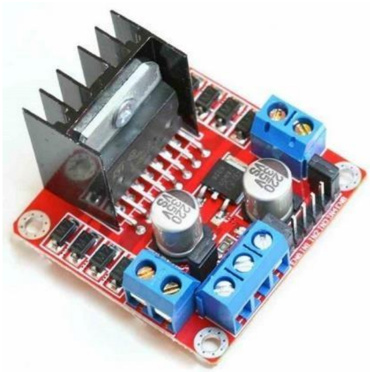
5. Mini Water Pump:

Micro DC 3-6V Micro Submersible Pump Mini water pump For Fountain Garden Mini water circulation System DIY project. This is a low cost, small size Submersible Pump Motor which can be operated from a 3 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

6. Relay Module:

A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a microcontroller. When activated, the electromagnet pulls to either open or close an electrical circuit.

7. L298N Motor Driver Module:



The L298N is a dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A. Let's take a closer look at the pinout of L298N module and explain how it works.

8. Jumper Wire:

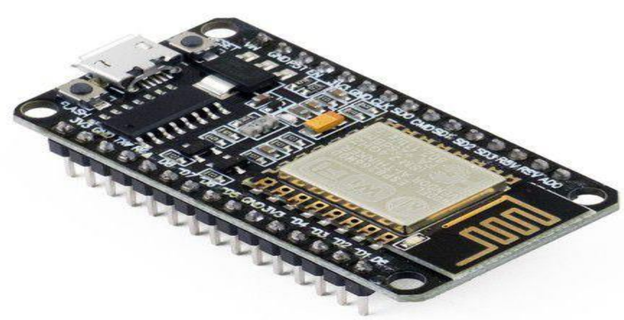
A jump wire is an electrical wire, or group of them in a cable, with a connector or pin at each end, which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

9. Rubber Wheel:

This is 65mm Robot Wheel for BO Motor(Yellow).

The wheel is made up of high-quality rubber which gives maximum traction while operating. The wheel is strong and sturdy as it features a nylon-reinforced plastic rim.

10. NodeMCU:



NodeMCU is an open-source development board based on the ESP8266 Wi-Fi module. It features a microcontroller, Lua-based firmware, and built-in Wi-Fi capabilities. NodeMCU is popular for IoT projects due to its ease of use, low cost, and extensive community support, making it an ideal choice for prototyping and connectivity applications.

Working and Principle

Designing a fire-fighting robot using the components you've listed involves a sophisticated interplay of sensors, motors, control modules, and a microcontroller to create a capable and autonomous fire-fighting system. The fundamental working principle of this robot revolves around the detection of fires, navigation towards the source, and fire suppression.

At the heart of the system is the Flame Sensor, which plays a pivotal role in fire detection. This sensor is designed to continuously scan the robot's environment for the presence of a fire or heat source. When it identifies such a source, it generates an electrical signal. This signal is then fed to the NodeMCU, which acts asthe central control unit for the robot.

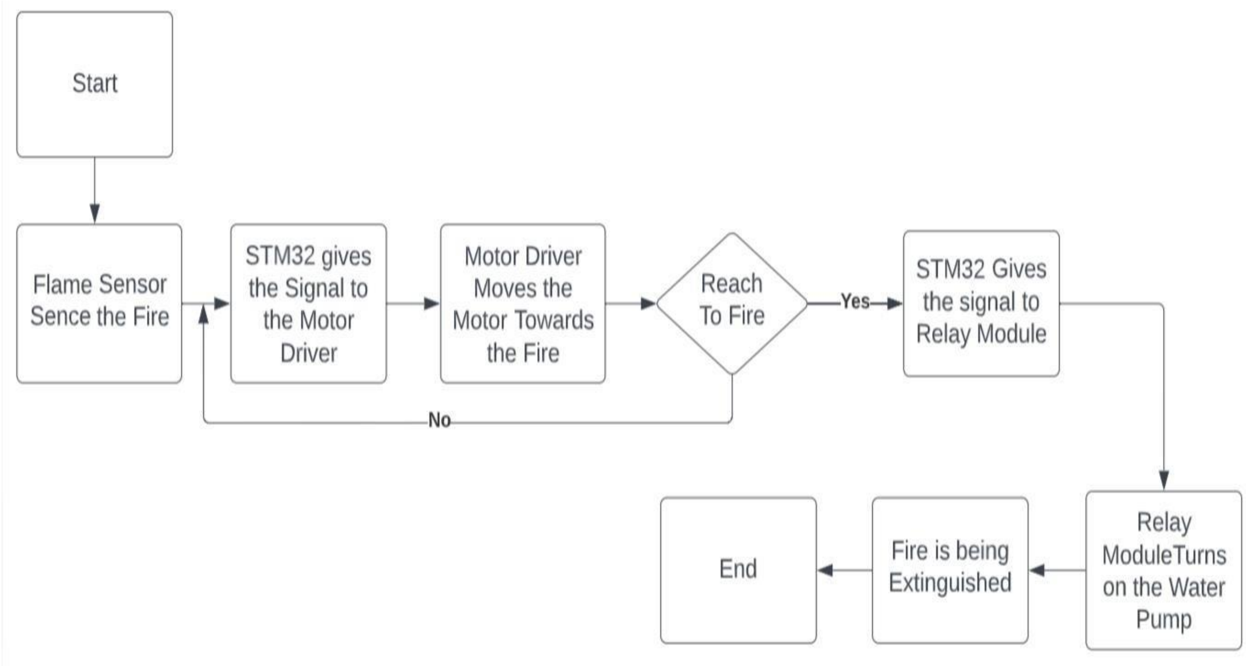
The NodeMCU serves as the brain of the operation, receiving data from the Flame Sensor and processing it to make informed decisions. When a fire is detected, the NodeMCU instructs the Micro Servo Motor to adjust theorientation of the Flame Sensor, allowing it to focus on the fire's precise location. This dynamic control of the sensor's direction enhances the robot's accuracy in pinpointing the fire's source.

The robot's mobility is achieved through a Single Shaft Motor, which drives the rubber wheels to move the robot towards the detected fire. This motor's speed and direction are controlled by the L298N Motor Driver Module, allowing for smooth and precise navigation.

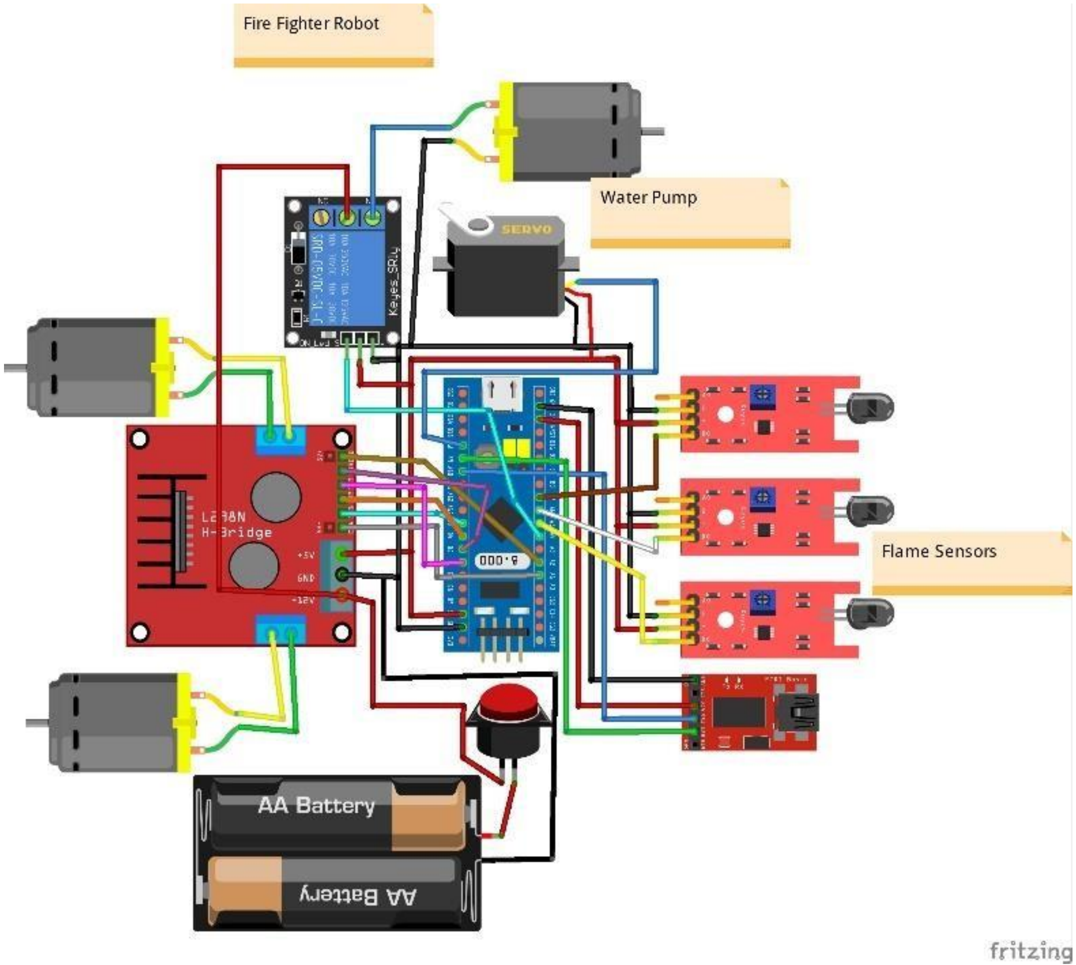
To suppress the fire, a Mini Water Pump is employed, and its activation is managed by a Relay Module. The NodeMCU, upon detecting the fire, sends commands to the Relay Module to power the water pump. This,in turn, initiates the process of extinguishing the fire by spraying water or fire-extinguishing foam.

To ensure the safety and effectiveness of the robot, the NodeMCU must be programmed to manage the coordinated efforts of these components. It communicates with the Flame Sensor, Micro Servo Motor, Single Shaft Motor, Relay Module, and L298N Motor Driver Module based on the fire detection data. Additionally, the NodeMCU can communicate with an external device or operator through the USB to SerialAdaptor, allowing for remote control, real-time monitoring, and data transmission.

Block Diagram



Circuit Diagram



Code:

```
#include <Adafruit_MLX90614.h>
#include <Servo.h>

#define pump D8
#define Flame_Sensor_1 D5
#define Flame_Sensor_2 D6
#define LMPositive D3
#define LMNegative D4
#define RMPositive D7
#define RMNegative 3

Servo myservo;
Adafruit_MLX90614 mlx = Adafruit_MLX90614();

bool fire = false;
double temp;
int pos = 0;

void Put_Off_Fire() {
  digitalWrite(LMPositive, LOW);
  digitalWrite(LMNegative, LOW);
  digitalWrite(RMPositive, LOW);
  digitalWrite(RMNegative, LOW);
  digitalWrite(pump, HIGH);
  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;
}

void setup() {
  Serial.begin(9600);
  pinMode(Flame_Sensor_1, INPUT);
  pinMode(Flame_Sensor_2, INPUT);
  pinMode(pump, OUTPUT);
  pinMode(LMPositive, OUTPUT);
  pinMode(LMNegative, OUTPUT);
  pinMode(RMPositive, OUTPUT);
  pinMode(RMNegative, OUTPUT);
  myservo.attach(D0, 500, 2500);
  myservo.write(0);
  digitalWrite(pump, LOW);

  if (!mlx.begin()) {
```

```
    Serial.println("Error connecting to MLX sensor. Check wiring.");
    while (1);
  }
}

void loop() {
  temp = mlx.readObjectTempC();
  Serial.println(temp);
  delay(2000);

  int value1 = digitalRead(Flame_Sensor_1);
  int value2 = digitalRead(Flame_Sensor_2);
  Serial.print("Sensor 1 value ");
  Serial.println(value1);
  Serial.print("Sensor 2 value ");
  Serial.println(value2);

  if (digitalRead(Flame_Sensor_1) == HIGH && digitalRead(Flame_Sensor_2) == HIGH) {
    digitalWrite(LMPositive, HIGH);
    digitalWrite(LMNegative, LOW);
    digitalWrite(RMPositive, HIGH);
    digitalWrite(RMNegative, LOW);
  } else if (digitalRead(Flame_Sensor_1) == HIGH && digitalRead(Flame_Sensor_2) == LOW) {
    digitalWrite(LMPositive, LOW);
    digitalWrite(LMNegative, HIGH);
    digitalWrite(RMPositive, HIGH);
    digitalWrite(RMNegative, LOW);
  } else if (digitalRead(Flame_Sensor_1) == LOW && digitalRead(Flame_Sensor_2) == HIGH) {
    digitalWrite(LMPositive, HIGH);
    digitalWrite(LMNegative, LOW);
    digitalWrite(RMPositive, LOW);
    digitalWrite(RMNegative, HIGH);
  } else {
    Serial.println("NOTHING");
  }

  if (temp > 45 && !fire) {
    Put_Off_Fire();
}
}
```

CONCLUSION

In conclusion, the development and deployment of fire-fighting robots represent a significant step forward in enhancing firefighting capabilities, particularly in hazardous and challenging environments. These robots leverage advanced technologies, including sensors for fire detection, precise navigation systems, and effective fire suppression mechanisms, to autonomously combat fires. By employing a central control unit and secure communication protocols, they enable remote operation and real-time monitoring, ensuring both the safety of human operators and the effectiveness of firefighting efforts.

Safety measures and regulatory compliance are of paramount importance to mitigate risks associated with fire-fighting robot operations. Fail-safe mechanisms, fire-resistant materials, and adherence to established safety standards are critical elements of their design.

The cost-effectiveness of fire-fighting robots compared to traditional firefighting methods is a subject of ongoing research and consideration, as these robots offer the potential for significant time and resource savings.

Real-world deployments and case studies have demonstrated the practical utility of fire-fighting robots in scenarios ranging from industrial fires to wildfires. These deployments underscore the robots' ability to operate in environments where human intervention is limited or perilous.

While the field of fire-fighting robots has made significant strides, continuous research and development are necessary to improve their performance, safety, and adaptability. As technology evolves, these robots are likely to become even more capable and play a critical role in safeguarding lives and property from the devastating effects of fires in diverse settings. Fire-fighting robots are a promising addition to the firefighting toolkit, offering an innovative and versatile solution to an age-old problem.

Future Scope

1. Improved Mobility: Future fire-fighting robots will likely have enhanced mobility, allowing them to navigate through challenging terrains, such as collapsed buildings, tunnels, or rough outdoor environments. This could involve advanced legged designs, track systems, or even aerial capabilities for accessing high-rise buildings.

2. Autonomous Navigation: Developments in artificial intelligence and machine learning will enable fire-fighting robots to navigate autonomously, assess the environment, and make real-time decisions to locate and combat fires. They can adapt to changing conditions, avoid obstacles, and choose the most efficient path.

3. Enhanced Sensing and Detection: Advanced sensors, such as thermal cameras, gas detectors, and environmental sensors, will enable fire-fighting robots to detect fires, hazardous materials, and the presence of victims even in low-visibility environments. Integration with AI can enhance the interpretation of sensor data.

4. Fire Suppression Capabilities: Fire-fighting robots can be equipped with more effective fire suppression mechanisms, such as improved water cannons, foam sprayers, or other extinguishing agents. These systems can be controlled remotely by firefighters or operate autonomously based on the fire's behavior.

References

1] Hossain, Md Anowar, Himaddri Shakhar Roy, Md Fazlul Karim Khondakar, Md Hasib Sarowar, and Md Azad Hossainline. "Design and Implementation of an IoT Based Firefighting and Affected Area Monitoring Robot." In 2021 2nd International Conference on Robotics, Electrical and Signal ProcessingTechniques (ICREST), pp. 552-556. IEEE,2021.

[2] Pramod, B.N., K.N.Hemalatha, B. J. Poornima, andR.Harshitha. "Fire Fighting Robot." In 2019 International Conference on Information and Communication Technology Convergence (ICTC), pp. 889-892. IEEE, 2019.

[3] Aliff, Mohd, M. Yusof, Nor Samsiah Sani, and Azavitra Zainal. "Development offirefighting robot(QROB)."Development 10, no. 1 (2019).

[4] Mittal, Shiva, Manish Kumar Rana, Mayank Bhardwaj, Meenakshi Mataray, and Shubham Mittal. "CeaseFire: the firefighting robot." In 2018 International Conference on Advances in Computing, Communication ControlandNetworking(ICACCCN), pp. 1143-1146. IEEE, 2018.

[5] Raj, P. Anantha, and M. Srivani. "Internet of Robotic Things based autonomous fire-fighting mobile robot." In 2018 IEEE International Conference on Computational Intelligence and Computing Research (ICCIC), pp. 1-4. IEEE, 2018.