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Fire Fighting Robot

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ABSTRACT
Fire disasters can be extremely hazardous, often resulting in loss of life and property. Traditional firefighting methods expose individuals to significant danger. This paper proposes a low-cost, mobile robotic solution aimed at detecting and extinguishing fires autonomously. The Fire Fighting Robot is a prototype developed using embedded systems and sensor technologies to detect the presence of fire and respond accordingly.
The robot is controlled by an Arduino Uno and uses flame and temperature sensors to detect fire sources. Upon detection, the robot navigates towards the fire using DC motors and extinguishes it with a water pump mechanism controlled by a relay. The robot can also be manually operated using a Bluetooth or RF module. This system provides a scalable and cost- effective fire suppression solution suitable for residential, industrial, and educational applications.

1. INTRODUCTION
The increasing number of fire-related incidents and their devastating effects have highlighted the need for technological interventions in fire safety. Firefighting is a risky occupation, and human lives are often at stake. This paper introduces a Fire Fighting Robot that uses sensors and embedded systems to detect and extinguish small fires autonomously. The goal is to minimize human involvement in hazardous situations and offer a practical solution for early fire suppression.

2. LITERATURE SURVEY
Several robotic systems have been proposed for fire detection and suppression, ranging from simple sensor-based bots to advanced AI-controlled robots. Most systems focus on either detection or suppression but lack integration. This project bridges the gap by incorporating both features in a compact, mobile robot. Prior works include:

- Infrared-based fire detectors
- GSM-based fire alert systems
- Remote-controlled fire trucks

3. SYSTEM ARCHITECTURE
The system includes an Arduino Uno microcontroller, flame and temperature sensors for detection, a motor driver for navigation, and a water pump module for extinguishing the fire. The control logic is

programmed in Arduino IDE. Wireless communication is established through a Bluetooth or RF module.

4. COMPONENTS USED

ArduinoUNO

Acts as the main control unit that processes sensor data and controls the motors and pump based on programmed logic.

FlameSensor

Detects the presence of fire or flame. Signals the microcontroller to initiate fire-extinguishing processes.

UltrasonicSensor

Used for obstacle detection to navigate the robot and avoid collisions during movement.

L293DMotorDriver

Controls the direction and speed of the DC motors based on Arduino commands.

DCGearedMotor

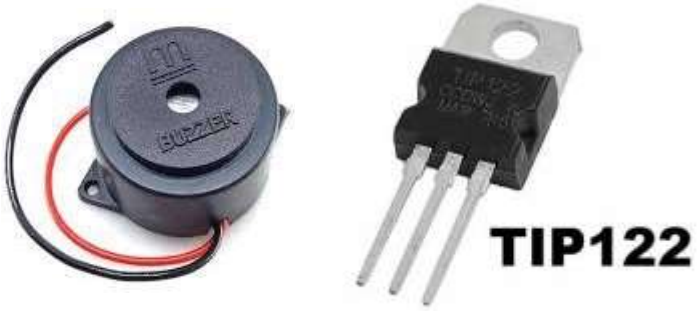
Provides the mechanical drive to the robot wheels, allowing movement in various directions.

6x2LCDDisplay

Displays real-time system status like flame detection, distance to obstacles, or motor status.

Buzzer

Emits an alarm when fire is detected, alerting nearby individuals.



2VRechargeableBattery

Powers the entire system including motors, sensors, and control board.

WaterPumpMotor

Pumps and sprays water to extinguish detected fire.

TIP122Transistor
Acts as a switch to control high-current components like the water pump.

MDFBoard
Base structure or chassis of the robot that holds all components together.

RobotWheels
Provide mobility to the robot.

3PinToggleSwitch
Used to manually power ON/OFF the entire system.

7. WORKING PRINCIPLE

The robot continually monitors its environment using flame and temperature sensors. When it detects a fire (based on predefined threshold values), the Arduino processes the data and drives the motors toward the fire. Upon reaching close proximity, the Arduino activates a relay module connected to a water pump that sprays water to extinguish the fire. In manual mode, a user can control the robot's movement and activation through Bluetooth or RF remote.

8. RESULTS AND DISCUSSION

The prototype successfully demonstrated autonomous fire detection and extinguishing capabilities in a

controlled environment. The sensors were able to detect a flame within a 1-meter range, and the water pump effectively extinguished small fires. Manual control was tested using a Bluetooth app, allowing user override.

9. FEATURES

- Autonomous fire detection and suppression
- Wireless manual control
- Lightweight and compact design
- Rechargeable and low power consumption
- Capable of reaching fire sources in hazardous areas

10. LIMITATIONS

- Cannot handle large-scale fires
- Limited sensor detection range
- Suitable only for flat, indoor environments
- Lacks obstacle avoidance

11. APPLICATIONS

- Residential fire safety
- Factory and warehouse surveillance
- Computer/server room protection
- Educational and research demonstrations
- Early response in public spaces

12. FUTURE SCOPE

- Integration with obstacle avoidance systems
- GSM-based SMS alert system for emergency notification
- AI-based autonomous navigation
- Camera module for live video feed
- Upgrading fire extinguisher module to handle chemical/electrical fires

13. CONCLUSION

The Fire Fighting Robot provides an effective and safe way to tackle small-scale fire incidents without endangering human lives. With simple electronics and intelligent programming, the robot successfully detects and extinguishes fire. Future upgrades can further enhance its usability, autonomy, and application in real- world scenarios.

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