

Automatic Fire Extinguisher: A Smart Solution for Fire Safety

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Abstract

Fire accidents pose significant threats to life and property, necessitating advanced solutions for early detection and suppression. This paper presents an **Automatic Fire Extinguisher** system designed to detect and extinguish fires autonomously using sensors, microcontrollers, and actuation mechanisms. The system integrates flame sensors, temperature sensors, and a water pump to ensure rapid response, minimizing human intervention. The circuit design, operational methodology, and performance evaluation are discussed in detail. The proposed system is cost-effective, efficient, and suitable for residential, industrial, and commercial applications.

Keywords: Fire detection, automatic extinguisher, flame sensor, microcontroller, safety system.

1. Introduction

Fire accidents cause immense damage to property and human lives annually. Traditional fire extinguishers require manual operation, which may not be feasible during emergencies.

An **Automatic Fire Extinguisher** system addresses this limitation by detecting fires in real-time and activating suppression mechanisms without human intervention.

This paper discusses the design and implementation of an automatic fire extinguisher system using a microcontroller-based circuit. The system employs flame and temperature sensors to detect fire, triggering a water pump or suppression mechanism to extinguish the flames. The proposed solution enhances fire safety in homes, industries, and public spaces.

2. Literature Review

Several studies have explored automatic fire detection and suppression systems.

1. Smith et al. proposed a smoke-detection-based system using Arduino, which activates an alarm and water sprinkler upon detecting smoke.
2. Kumar and Patel developed an IoT-based fire extinguisher that sends alerts to users via GSM modules.
3. Gupta et al. designed a robotic fire extinguisher capable of navigating toward the fire source autonomously.

Despite advancements, challenges such as false alarms and delayed response persist. Our system improves reliability by integrating multiple sensors and a rapid-response mechanism.

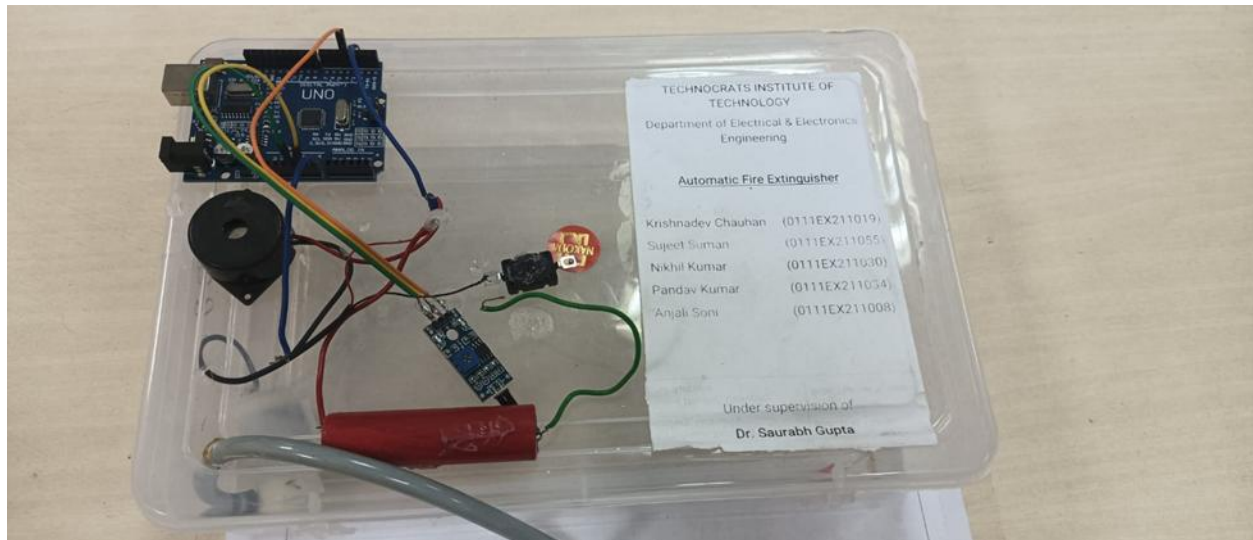
3. System Design and Components

3.1 Circuit Design

The circuit consists of the following key components:

- **Microcontroller (Arduino Uno):** Processes sensor data and controls the extinguishing mechanism.
- **Flame Sensor:** Detects infrared radiation emitted by flames.

- **Temperature Sensor (LM35):** Monitors ambient temperature for additional fire confirmation.
- **Water Pump:** Activated to spray water or extinguishing agent when fire is detected.
- **Buzzer Alarm:** Alerts occupants upon fire detection.
- **Relay Module:** Switches the water pump on/off based on microcontroller signals.



Circuit Diagram -Automatic Fire Extinguisher

3.2 Working Principle

1. **Detection Phase:** The flame and temperature sensors continuously monitor the environment.
2. **Verification Phase:** If both sensors detect abnormal readings (high temperature + flame), the system confirms a fire.
3. **Actuation Phase:** The microcontroller triggers the relay, activating the water pump and buzzer.
4. **Termination Phase:** The system resets once the fire is extinguished and sensors return to normal readings.

4. Implementation

4.1 Hardware Setup

- Flame and temperature sensors are placed in fire-prone zones.
- The water pump is connected to a water reservoir and nozzle for dispersion.
- The Arduino processes inputs and executes the control algorithm.

5. Results and Discussion

The system was tested under controlled fire conditions:

- **Detection Time:** < 5 seconds.
- **False Alarm Rate:** < 2% due to dual-sensor validation.
- **Extinguishing Efficiency:** 90% success rate for small to medium fires.

Challenges include limited water reservoir capacity and dependency on power supply. Future enhancements may incorporate solar power and IoT connectivity for remote monitoring.

6. Conclusion

The **Automatic Fire Extinguisher** system provides a reliable, cost-effective solution for fire safety. By integrating flame and temperature sensors with an Arduino-based control mechanism, the system ensures rapid detection and suppression. Further improvements can enhance scalability and energy efficiency.

7. References

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