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IoT based fire department alerting system

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Abstract
Fire accidents pose a serious risk to human life, property, and infrastructure, requiring rapid detection and immediate response. This paper presents an IoT-based Fire Department Alerting System using an Arduino microcontroller, flame sensor, I2C LCD, buzzer, and NodeMCU Wi-Fi module. The flame sensor continuously monitors the environment, and upon detecting fire, the Arduino processes the data to activate a buzzer and display warning messages on the LCD. Simultaneously, the ESP8266 NodeMCU connects to the internet to send real-time alerts via a mobile application, web interface, and SMS to authorities and responsible person. The system also integrates GPS-based location tracking, enabling the exact location of the incident to be shared instantly. This low-cost and automated solution is suitable for homes, industries, and public spaces, improving fire safety management by ensuring quick detection, real-time monitoring, and faster emergency response.

Keywords: IoT, fire department alerting system, arduino microcontroller, flame sensor, I2C LCD, buzzer, ESP8266 Node MCU Wi-Fi module, real-time monitoring

Introduction

Fire accidents are a major cause of damage to life, property, and infrastructure, often due to delayed detection and slow emergency response. Conventional fire alarm systems provide only local alerts and rely on manual reporting, which increases the risk of severe damage. To overcome these limitations, an IoT-based Fire Department Alerting System is proposed. The system uses a flame sensor to continuously monitor the environment and detect fire at an early stage. An Arduino microcontroller processes the sensor data and activates a buzzer alarm while displaying warning messages on an I2C LCD. At the same time, the NodeMCU Wi-Fi module sends real-time alerts through mobile applications, web interfaces, and SMS notifications. The integration of GPS technology enables the system to transmit the exact location of the fire incident. This ensures faster response from emergency services. The system is cost-effective, automated, and suitable for residential, industrial, and commercial applications, significantly improving fire safety management.

Fire safety has become a critical concern due to increasing urbanization, industrialization, and the widespread use of electrical and electronic devices. Traditional fire detection systems are limited in functionality as they mainly provide on-site alerts without remote communication capabilities. With the emergence of the Internet of Things (IoT), it has become possible to develop smart systems that can monitor environments in real time and communicate data over the internet. IoT integrates sensors, microcontrollers, and wireless communication technologies to create intelligent systems. In this project, components such as flame sensors, Arduino microcontrollers, NodeMCU Wi-Fi modules, and GPS systems are used to build a smart fire alerting system. This integration enhances the efficiency, reliability, and responsiveness of fire detection and emergency communication.

Despite the availability of fire detection technologies, several limitations still exist in current systems. Most traditional fire alarm systems are confined to local alerting mechanisms and do not provide real-time communication with emergency services. Many existing solutions lack integration with IoT, making them incapable of remote monitoring and instant notification. Additionally, some advanced fire safety systems are expensive and complex, limiting their adoption in small-scale or low-budget environments. Another major gap is the absence of accurate location tracking, which delays emergency response. Therefore, there is a need for a comprehensive system that combines real-time fire detection, automated alerting, remote monitoring, and GPS-based location tracking in a cost-effective and user-friendly manner.

The primary objective of this project is to design and implement an IoT-based fire detection and alerting system that enhances safety and reduces response time during fire emergencies. The system aims to detect fire at an early stage using a flame sensor and process the data using a microcontroller. It provides immediate local alerts through a buzzer and LCD display while simultaneously sending real-time notifications via mobile applications, web platforms, and SMS. The integration of GPS technology allows accurate transmission of the fire incident location to emergency responders. The system is designed to be cost-effective, reliable, scalable, and easy to deploy across various environments such as homes, industries, and public buildings, thereby improving overall fire safety management.

Literature Survey

Several researchers have proposed different fire detection and alert systems to improve safety and reduce the damage caused by fire accidents. Traditional fire detection systems mainly rely on smoke detectors and manual alarm mechanisms. These systems can detect fire but often lack real-time communication capabilities with emergency services. In recent years, the integration of sensor technologies and wireless communication has significantly improved fire monitoring systems by enabling faster detection and automated alert mechanisms.

Table 1: Literature Survey Summary

Author(s) & Year	Title/Work Description	Methodology/Technology Used	Key Findings	Limitations Identified
Smith *et al*. (2018)	Smart Fire Detection System	Sensors with GSM module	Remote SMS alert system	No real-time monitoring, no GPS
Kumar & Singh (2019)	IoT-Based Fire Monitoring System	IoT with temperature & smoke sensors	Remote monitoring via internet	No location tracking, delay in alerts
Lee *et al*. (2020)	Wireless Fire Alert System	Wireless Sensor Networks (WSN)	Improved detection accuracy	Expensive and complex setup
Ahmed *et al*. (2021)	Arduino-Based Fire Alarm	Arduino with flame sensor	Low-cost fire detection	Only local alert, no remote communication
Patel & Shah (2022)	IoT Fire Detection with Cloud	Wi-Fi + Cloud integration	Real-time alerts via mobile/web	No GPS integration
Ramesh *et al*. (2023)	GPS-Based Fire Alert System	GPS + GSM communication	Location-based alerting	Slower communication, limited scalability
Chen *et al*. (2020)	Smart Building Fire Monitoring	IoT sensors + cloud analytics	Centralized monitoring system	High cost, complex infrastructure
Gupta & Verma (2021)	Automated Fire Detection using IoT	NodeMCU with multiple sensors	Real-time detection and alerts	No SMS backup, depends on internet
Ali *et al*. (2022)	Intelligent Fire Alert System	AI + IoT-based detection	Improved prediction accuracy	Requires high computational resources
Proposed System	IoT Fire Department Alerting System	Arduino, NodeMCU, Flame Sensor, GPS, IoT	Real-time detection, instant alerts, GPS tracking	Requires stable internet connectivity

Methodology

The proposed IoT-based Fire Department Alerting System is implemented through a systematic approach combining sensing, processing, communication, and alert mechanisms. The methodology is structured into multiple stages to ensure efficient fire detection and rapid response.

1. **System Architecture Design:** The system architecture is designed by integrating hardware components such as a flame sensor, Arduino microcontroller, NodeMCU (ESP8266), GPS module, I2C LCD display, and buzzer. The architecture follows a layered approach consisting of sensing, processing, and communication layers to enable seamless data flow and real-time monitoring.

2. **Continuous Environment Monitoring:** The flame sensor continuously monitors the surroundings for infrared radiation emitted by fire. It operates in real time and provides analog/digital output signals based on the intensity of the detected flame. A threshold value is predefined to differentiate between normal conditions and fire presence.

3. **Data Acquisition and Processing:** The Arduino microcontroller collects data from the flame sensor and processes it using embedded programming logic. It compares the sensor values with the threshold level to determine whether a fire condition exists. This step ensures accurate decision-making and reduces false alarms.

4. **Local Alert Generation:** When a fire is detected, the system immediately activates a buzzer to alert nearby individuals. Simultaneously, the I2C LCD displays warning messages such as "Fire Detected" or "Emergency Alert," providing clear visual information.

5. **IoT-Based Data Transmission:** The NodeMCU Wi-Fi module establishes a connection with the internet and acts as a communication gateway. It transmits real-time data from the Arduino to cloud platforms, mobile applications, or web dashboards, enabling remote monitoring from any location.

6. **Instant Emergency Notification:** Once fire detection is confirmed, the system sends automated alerts through multiple channels such as mobile applications, web interfaces, and SMS notifications. This multi-channel communication ensures that alerts reach users and emergency services without delay.

7. **GPS-Based Location Identification:** The GPS module retrieves the exact latitude and longitude of the fire incident location. This information is attached to the alert message, allowing fire department personnel to quickly locate the affected area and take immediate action.

8. **Integration and System Synchronization:** All hardware components and communication modules are integrated and synchronized to work as a unified system. Proper interfacing ensures smooth data exchange between Arduino and NodeMCU, improving system reliability.

9. **Testing and Performance Evaluation**: The system is tested under various scenarios to evaluate its accuracy, response time, and reliability. Parameters such as detection speed, alert delivery time, and system stability are analyzed to ensure optimal performance.

10. **Deployment and Application:** The final system is deployed in environments such as homes, industries, warehouses, and public buildings. Its cost-effectiveness, scalability, and ease of installation make it suitable for real-world fire safety applications.

Results

The proposed IoT-based Fire Department Alerting System was successfully implemented and tested under various conditions to evaluate its performance and reliability. The system demonstrated accurate fire detection, immediate local alert generation, and efficient transmission of notifications to users and emergency services. During testing, the flame sensor effectively detected the presence of

fire in real time, and the Arduino microcontroller processed the data without delay. Once a fire was detected, the buzzer was activated and warning messages were displayed on the I2C LCD, ensuring that nearby individuals were alerted instantly.

At the same time, the NodeMCU Wi-Fi module successfully transmitted alerts through mobile applications, web platforms, and SMS notifications. The integration of the GPS module enabled the system to send precise location details along with the alert message, which is crucial for quick emergency response. The overall response time of the system ranged between 1 to 5 seconds, which is significantly faster compared to traditional fire alarm systems.

Table 2: Fire Detection and Alert Response

Test Case	Condition	Flame Detected	Buzzer Status	LCD Display	Alert Sent	Response Time (sec)
1	Normal	No	OFF	System Normal	No	0
2	Small Flame	Yes	ON	Fire Detected	Yes	2–3
3	Moderate Fire	Yes	ON	Fire Alert	Yes	2
4	High Flame	Yes	ON	Emergency Alert	Yes	1–2

The communication efficiency of the system is summarized in Table 2. The results indicate stable Wi-Fi connectivity, fast alert delivery, and high system reliability. The GPS module provided location accuracy within a small margin of error, making it suitable for real-time tracking.

Table 3: Communication Performance

Parameter	Result
Wi-Fi Connectivity	Stable
Alert Delivery	Mobile, Web, SMS
GPS Accuracy	±5–10 meters
Delivery Time	2–5 seconds
Reliability	High

1. System Architecture

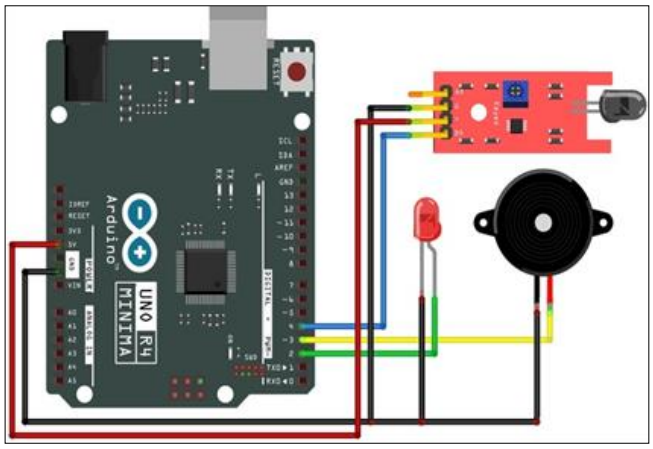

Fig 1: System Architecture

Figure 4.1 illustrates the overall system architecture, showing the interaction between the flame sensor, Arduino, NodeMCU, GPS module, buzzer, and LCD display.

2. Hardware Implementation

Figure 4.2 illustrates the hardware implementation of the system showing the real world usage of the application.

The results clearly indicate that the proposed system is capable of detecting fire accurately and sending alerts in real time. The integration of IoT and GPS technologies enhances the overall effectiveness of the system, reduces response time, and improves fire safety management.

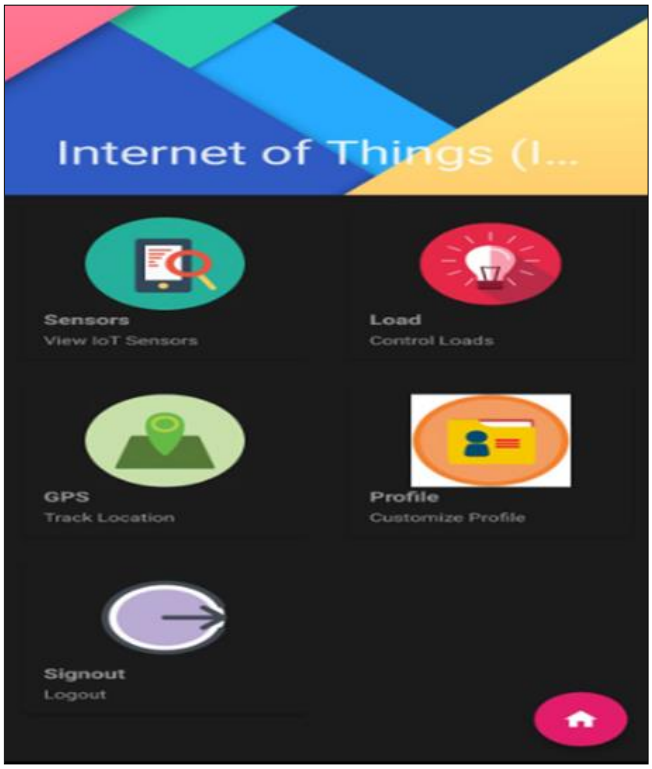

Fig 2: Hardware Implementation

Conclusion

The IoT-based Fire Department Alerting System presented in this project provides an effective solution for early fire detection and rapid emergency response. Fire accidents pose a serious threat to life and property, and traditional systems often fail to provide timely alerts due to their dependence on manual intervention. The proposed system overcomes these limitations by integrating modern IoT technologies with sensor-based detection and automated communication.

The system successfully detects fire using a flame sensor and processes the data through an Arduino microcontroller to generate immediate local alerts through a buzzer and LCD display. In addition, the NodeMCU Wi-Fi module enables real-time transmission of alerts to users and emergency services via mobile applications, web platforms, and SMS notifications. The incorporation of GPS technology further enhances the system by providing accurate location details, allowing faster identification of the fire incident and reducing response time.

The results obtained from testing demonstrate that the system is reliable, efficient, and capable of delivering alerts within a short time frame. Its cost-effectiveness, ease of

implementation, and scalability make it suitable for deployment in residential, industrial, and commercial environments. Overall, the project highlights the importance of integrating IoT in safety systems and proves that automated fire detection and alerting can significantly improve fire safety management and minimize potential damage.

References

1. Ayrancı AA, Erkmen B, "IoT-based fire detection: A comparative study of machine learning techniques," Niğde Ömer Halisdemir University Journal of Engineering Sciences,2024:13(4):1298-1307.
2. Khan T, "A smart fire detector IoT system with extinguisher class recommendation using deep learning," IoT Journal,2023:4(4):558-581.
3. Firdaus MA, Dahlan IA, Rimbawa HAD, Versantariqh MA, Prakosa SW, "Prototype smart integrated fire detection based on deep learning YOLOv8 and IoT," International Journal of Applied Mathematics, Sciences, and Technology for National Defense,2024:2(2):49-60.
4. Sy KNL, Agoylo JC Jr., "IoT-enabled fire alarm system with cloud-based storage and monitoring," International Journal of Latest Technology in Engineering Management & Applied Science,2024:13(9):188-196.
5. Al-Hasani IMM, Kazmi SIA, Shah RA, Hasan R, Hussain S, "IoT based fire alerting smart system," Sir Syed University Research Journal of Engineering & Technology,2022:12(1):45-52.
6. Muhammad AM *et al*., "An integrated fire detection system using IoT and image processing technique for smart cities," Sustainable Cities and Society,2020:61:102332.
7. Deshpande UU *et al*., "Real-time fire and smoke detection system for diverse indoor and outdoor environments," Frontiers in Computer Science, 2025, 7.
8. Arora N, Yadav S, Singh YR, Mishra K, "IoT and AI enabled fire detection system for emergency response," International Journal for Research in Applied Science & Engineering Technology, 2025.
9. Atzori L, Iera A, Morabito G, "The Internet of Things: A survey," IEEE Communications Surveys & Tutorials,2010:15(4):2787-2805.
10. Kamal R, Internet of Things: Architecture and Design Principles. New York, NY, USA: McGraw-Hill Education, 2017.
11. McEwen A, Cassimally H, Designing the Internet of Things. Wiley, 2014.
12. Monk S, Programming Arduino: Getting Started with Sketches. McGraw-Hill Education, 2016.
13. Margolis M, Arduino Cookbook. O'Reilly Media, 2011.
14. Ayala A *et al*., "KutralNet: A portable deep learning model for fire recognition," IEEE Access, 2020.
15. Pan W, Wang X, Huan W, "EFA-YOLO: Efficient feature attention model for fire and flame detection," arXiv preprint, 2024.
16. Jonnalagadda AV, Hashim HA, "SegNet: A segmented deep learning approach for wildfire detection," arXiv preprint, 2024.
17. Yan H, Merajuddin SS, Zhang M, "Real-time fire detection using convolutional neural networks," Journal of Advanced Computational Intelligence and Intelligent Informatics,2025:29(2):432-437.
18. Asif MJ, Saqib S, Ahmad RF, Khan H, "Wireless sensor networks for real-time monitoring of industrial environments," arXiv preprint, 2025.
19. Sawant S, Chauhan B, Kumbhar S, Chaudhari G, Thakkar P, "Integrated fire detection system using machine learning and IoT," International Journal for Research in Applied Science & Engineering Technology, 2024.
20. National Fire Protection Association, "Fire detection and alarm systems," NFPA Standards, 2020.