Design, Modelling and Fabrication of Advanced Robots

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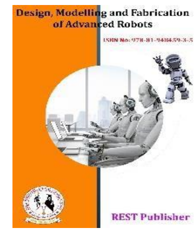

Development of Flammable Fluid Monitoring System Using IOT

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Abstract: *Flammable fluids such as petrol, diesel, and chemical solvents pose significant risks in industries due to their volatile nature. Accidental leaks or vapor accumulation can lead to catastrophic fires and explosions if not detected promptly. This paper presents the design and implementation of a Flammable Fluid Monitoring System using Internet of Things (IoT) technology. The system integrates multiple sensors — gas, flame, and pressure sensors — to continuously monitor environmental conditions in storage and transfer zones. Sensor data are processed by a microcontroller and transmitted via Wi-Fi to a cloud platform for real-time visualization and alerts. When hazardous conditions are detected, the system automatically triggers alarms and notifies users through an IoT dashboard, ensuring timely preventive actions. The system demonstrates the potential of IoT in enhancing industrial fire safety, improving response time, and reducing losses due to flammable-fluid hazards.*

1. INTRODUCTION

Flammable fluids are integral to numerous industrial operations but present a constant safety hazard due to their tendency to vaporize and ignite easily. Traditional safety mechanisms depend largely on manual inspection and periodic maintenance, which are prone to delays in identifying leaks or pressure fluctuations. In high-risk environments such as fuel storage depots, chemical plants, and refineries, these limitations can lead to major fire and explosion incidents. To address these challenges, the proposed system utilizes IoT technology to develop a real-time, automated monitoring framework capable of detecting potential risks early and alerting users remotely. The integration of sensors, wireless communication, and cloud-based monitoring ensures continuous data collection and timely response, thereby improving industrial safety standards and operational reliability.

2. LITERATURE REVIEW

Several research works have explored the use of IoT in industrial monitoring and hazard detection. Bhattacharyya (2022) demonstrated an IoT-based fire and gas detection model, emphasizing wireless data transmission for industrial safety. Kumar et al. (2023) proposed an embedded gas detection and alert system using IoT, while Rajesh and Srinivasan (2022) developed a smart safety network for fuel storage facilities. These studies confirm that IoT-based monitoring reduces response time and enhances situational awareness. However, existing systems often focus on a single parameter (e.g., gas detection) and lack integration with flame or pressure sensors. This project bridges that gap by creating a multi-sensor IoT-based platform capable of comprehensive flammable-fluid monitoring.

3. DESIGN

The Flammable Fluid Monitoring System is structured around four key modules: Sensing, Processing, Communication, and Monitoring & Alert. Each module performs a distinct function to ensure reliable data acquisition and timely hazard alerts.

Sensing Module: Includes the MQ gas sensor (for detecting volatile gases), flame sensor (for fire presence), and pressure sensor (for tank pressure variations). These sensors continuously monitor environmental parameters.

Processing and Control Module: An Arduino Uno microcontroller collects the sensor readings, processes them, and compares the values against predefined safety thresholds.
Communication Module: An ESP8266 Wi-Fi module enables wireless data transmission to a cloud platform (Thing Speak or Blynk) for remote monitoring.
Monitoring and Alert Module: This module provides real-time visual and audible alerts through buzzer and LED indicators. It also transmits alert messages to the IoT dashboard for remote supervision.

4. COMPONENTS USED

TABLE 1.

Component	Description
Arduino Uno	Main microcontroller board for data processing
ESP8266 Wi-Fi Module	Enables IoT-based cloud communication
MQ Series Gas Sensor	Detects flammable vapors or gases
Flame Sensor	Detects presence of fire or ignition
Pressure Sensor	Measures tank or pipe pressure
Power Supply Module	Regulates voltage to circuit components
Buzzer and LED Indicators	Local alarm and visual warning
Thing Speak/Blynk Cloud Platform	For data visualization and remote alerts

5. BLOCK DIAGRAM DESCRIPTION

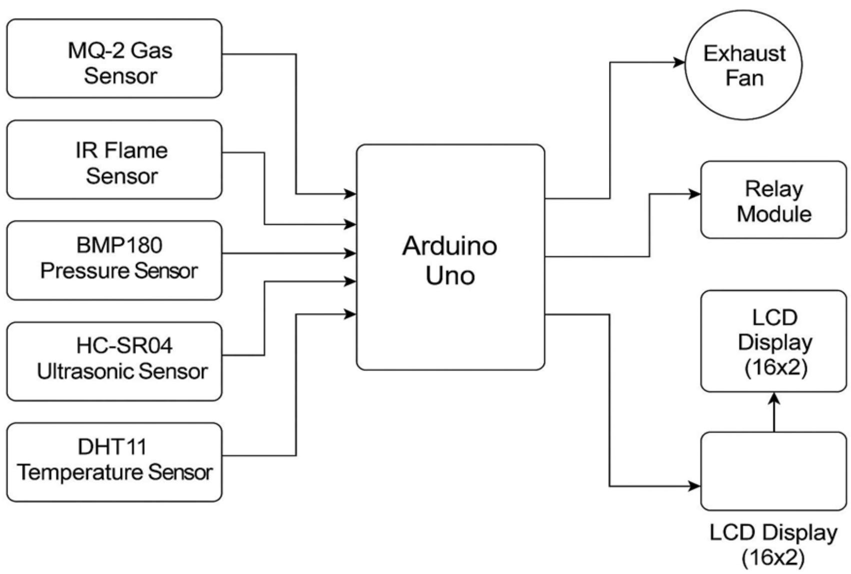

FIGURE 1.

6. CALCULATION

Power Consumption Analysis:

MQ Gas Sensor = 0.75 W
Flame Sensor = 0.30 W
Pressure Sensor = 0.25 W
ESP8266 = 0.50 W
Arduino Uno = 0.70 W
Total Power ≈ 2.5 W

Battery Specification:

7.4 V, 2200 mAh = 16.28 Wh

Runtime:

Runtime = 16.28 Wh ÷ 2.5 W = 6.5 hours of continuous operation per charge.

7. RESULTS AND DISCUSSION

The prototype was tested under controlled conditions simulating gas leaks and flame exposure. The system successfully detected hazardous levels and triggered both local and remote alarms within 2 seconds. Data transmission to the IoT dashboard was consistent, with real-time visualization of gas, pressure, and flame readings. The system proved stable, reliable, and effective for industrial use cases such as fuel storage yards, chemical plants, and refineries

8. CONCLUSION

The IoT-based flammable fluid monitoring system provides an efficient, affordable, and scalable safety solution for industries handling volatile substances. By integrating multi-sensor inputs with real-time cloud communication, it ensures early hazard detection and remote supervision Future Enhancements: Integration of GSM modules for SMS alerts. Use of AI-based predictive algorithms for hazard forecasting. Expansion to smart city and refinery automation systems.

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