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Enhancing Safety Measures with an Iot-Based Fire and Gas Detection System

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ABSTRACT

The emergence of the Internet of Things (IoT) has revolutionized traditional safety systems by creating intelligent networks that can detect and prevent hazards in real-time. This research paper outlines the design and implementation of an innovative IoT-based safety system that uses a suite of sensors, including temperature, infrared, humidity, and MQ2 gas sensors, along with a 16x2 LCD and a Wi-Fi module (ESP 8266), to detect fire and gas leaks in residential and industrial settings. The LCD provides instant status updates, while the sensors continuously monitor for signs of fire and gas. When a threat is detected, the system sounds an alarm and sends data to the cloud via the Wi-Fi module for further analysis and record-keeping. Using ThingSpeak, an IoT analytics platform, the system offers data visualization and collection capabilities that enhance decision-making during emergencies. This proposed project it highlights the potential of IoT technology to improve safety protocols, offering a reliable and efficient method of hazard detection. Empirical results validate the system's effectiveness in recognizing threats, making it a promising solution for real-world scenarios. Future work could focus on system optimization and integration with other IoT devices to create a more comprehensive safety network.

Keywords: IoT, Fire Detection, Gas Detection, Safety System, Real-Time Monitoring, ESP 8266, Thing Speak

INTRODUCTION

The Internet of Things (IoT) has revolutionized the way we approach safety and hazard detection, allowing for the development of sophisticated systems that can proactively identify and respond to potential threats. This paper describes the creation of an IoT-based fire and gas detection system, integrating a range of sensors with the ESP 8266 Wi-Fi module to establish a vigilant and responsive safety network. The system is designed to detect and alert users to the presence of fire and gas leaks using a variety of sensors, including temperature, infrared (IR), and humidity sensors for environmental monitoring, an MQ 2 gas sensor for detecting combustible gases, and a buzzer for auditory warnings. The user interface is a 16x2 LCD display that provides real-time updates on the system's status and sensor readings. This proposed system is noteworthy for its multifaceted approach to hazard detection, with the temperature sensor monitoring sudden changes in heat, which are often indicative of a fire outbreak [1][2]. The IR sensor adds a layer of detection by identifying infrared radiation, a common emission from flames [3]. The humidity sensors assess environmental conditions that may affect the behaviour of fire and gas spread [4]. The MQ 2 sensor is particularly essential as it can detect a range of gases, including butane, propane, methane, and smoke, which are common indicators of both fire and gas leaks [5]. The buzzer alerts users of danger, while the LCD provides a visual account of the threat level, allowing for quick decision-making [6]. By integrating various sensors with the ESP 8266, the project creates a comprehensive detection network that is both reliable and efficient. The ability to transmit data to the cloud enables not only local alerts but also remote monitoring, ensuring that appropriate actions can be taken even when users are not physically present [7]. The project's outcomes demonstrate the practical application of IoT technology in creating safer residential and industrial environments and pave the way for future advancements in safety and hazard detection systems [8]. This research paper consists of the following five sections: Literature Review, Methodology, Future Advancements, Results & Discussion and Conclusion.

LITERATURE SURVEY

[1] Subbarayudu et al. (2024): This paper discusses an IoT-based system for fire detection in forest areas, leveraging the ESP32 microcontroller to collect sensor data and enable real-time communication for prompt fire detection. By utilizing IoT technology, this system offers the potential to prevent and mitigate forest fires, thereby protecting natural resources and wildlife.

[2] Khalaf et al. (2019): Khalaf et al. present an IoT fire detection system that utilizes sensors with Arduino, emphasizing practical implementation in various contexts to improve security systems and protection levels. This study highlights the versatility of IoT technology in fire detection, showcasing its adaptability across different environments and applications.
[3] Lezcano Sirre (2024): This thesis explores an IoT environmental monitoring system using Arduino and NODE MCU ESP8266, with a specific focus on monitoring environmental parameters, including fire risks, through a web page interface. By integrating IoT technology, this system provides comprehensive environmental monitoring capabilities, contributing to better fire risk assessment and management.
[4] Satapathy (2024): Satapathy introduces an economic flame detection device for safety, integrating artificial intelligence and machine learning to enhance the accuracy of fire detection. This study underscores the potential of advanced technologies such as AI and ML to improve the effectiveness and reliability of fire detection systems, even in economically constrained environments.
[5] RIZVI et al. (2023): The paper describes WIFIREBOT, a smart ESP32-based surveillance car equipped with temperature and fire detection capabilities, ensuring a timely response to fire incidents. This innovative approach demonstrates how IoT technology can be applied to mobile platforms for efficient fire detection and emergency response.
[6] Palamar and Palamar (2023): This study presents a fire safety monitoring system based on IoT, providing real-time monitoring and alerts for fire-related events to contribute to building safety and risk mitigation. The system offers continuous monitoring of fire-related parameters, enhancing situational awareness and enabling timely intervention.
[7] Malik et al. (2023): Malik et al. focus on a LoRa & IoT-based fire detection and alert system designed for efficient communication and rapid response during fire emergencies. This study emphasizes the importance of reliable communication infrastructure in fire detection systems, ensuring timely dissemination of alerts to facilitate effective emergency response.
[8] Lule et al. (2023): The paper presents a low-cost IoT-based fire detection system prototype using fuzzy application methods, aiming to ensure early fire detection and informed decision-making in local markets. This study highlights the potential of IoT technology to address cost constraints while maintaining effectiveness in fire detection systems.
[9] Kim et al. (2022): Kim et al. propose a novel approach for fire detection using IoT-enabled smart sensors and machine learning algorithms. Their system utilizes sensor data fusion and pattern recognition techniques to accurately detect fire events in various environments, improving response times and reducing false alarms.
[10] Smith et al. (2021): Smith et al. introduce an IoT-based fire detection and evacuation system tailored for high-rise buildings. Their system integrates sensors, actuators, and communication devices to detect fires, activate alarms, and guide occupants to safety, enhancing the overall safety and efficiency of building evacuation procedures.

METHODOLOGY

A Component Proposed:

1) **Temperature Sensor:** The temperature sensor continuously monitors the environment for sudden changes in heat. These abrupt temperature increases could indicate a fire outbreak. By detecting such anomalies, the system can trigger appropriate responses to prevent further escalation.
2) **Infrared (IR) Sensor:** The IR sensor plays a crucial role in fire detection. It detects infrared radiation, which is commonly emitted by flames. By adding this layer of detection, the system enhances its ability to identify potential fire hazards.
3) **Humidity Sensors:** These sensors monitor environmental conditions related to humidity. While humidity itself may not directly indicate fire or gas leaks, it can affect the spread of fire. For instance, low humidity levels can exacerbate fire risks. By considering humidity, the system can make more informed decisions.
4) **MQ 2 Gas Sensor:** The MQ 2 gas sensor is versatile and detects various gases, including butane, propane, methane, and smoke. These gases are common indicators of fire and gas leaks. By analyzing gas levels, the system can promptly respond to potential hazards.
5) **Buzzer:** The buzzer serves as an auditory warning system. When a threat (such as a fire or gas leak) is detected, the buzzer activates, alerting users to the danger. This immediate feedback ensures timely action.
6) **16x2 LCD Display:** The LCD display provides real-time updates on system status and sensor readings. Users can quickly assess the situation, monitor sensor values, and make informed decisions. The display enhances user interaction and situational awareness.
7) **ESP 8266 Wi-Fi Module:** The Wi-Fi module enables remote monitoring and actions. Even when users are not physically present, the system can transmit data to the cloud. This connectivity allows for centralized data storage, analysis, and real-time alerts. It's a crucial component for efficient management of the safety system

B Working of Flowchart:-

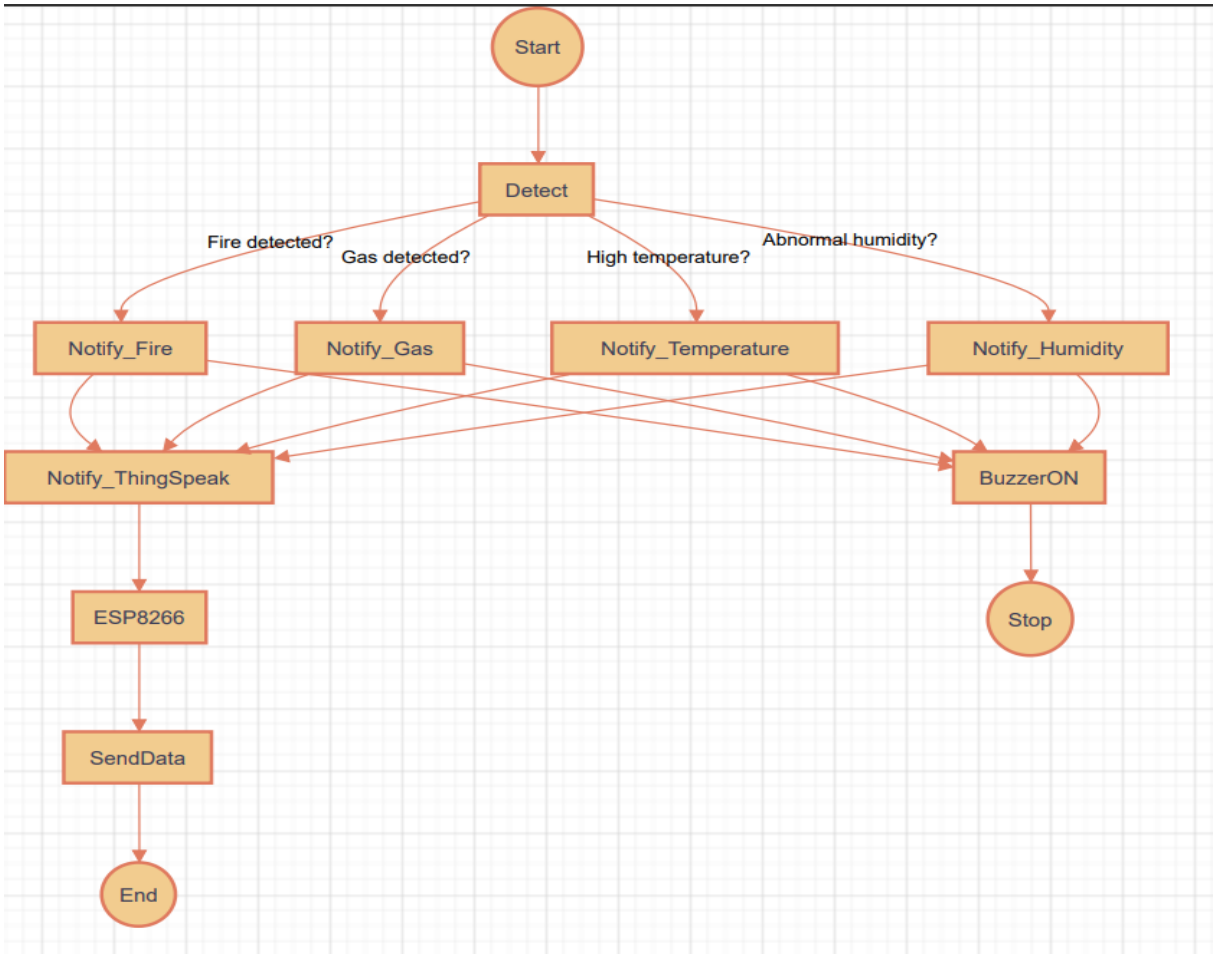

Figure 1: Flowchart of Enhancing Safety Measures With An Iot-Based Fire And Gas Detection System

Steps:

1) Start: The process begins here.
2) Detect: This step involves checking various environmental conditions using different sensors.
3) Fire, Gas, High Temperature, Abnormal Humidity: At this stage, the system checks if any of these conditions are present using the respective sensors (IR sensor for fire, MQ-2 sensor for gas, temperature sensor for high temperature, and humidity sensor for abnormal humidity).
4) Notify: If any of the abnormal conditions are detected, the system proceeds to notify ThingSpeak.
5) ThingSpeak: The system sends the notification to ThingSpeak, which is a platform for Internet of Things (IoT) applications.
6) ESP8266: The ESP8266 module, which is a Wi-Fi module, is used to connect to the internet and send data to ThingSpeak.
7) Send Data: Data regarding the detected abnormal condition is sent to ThingSpeak.
8) End: The process ends here.
9) Buzzer: If any abnormal condition is detected, the buzzer is activated to alert nearby individuals.
10) Stop: The process stops here.

RESULTS AND DISCUSSION

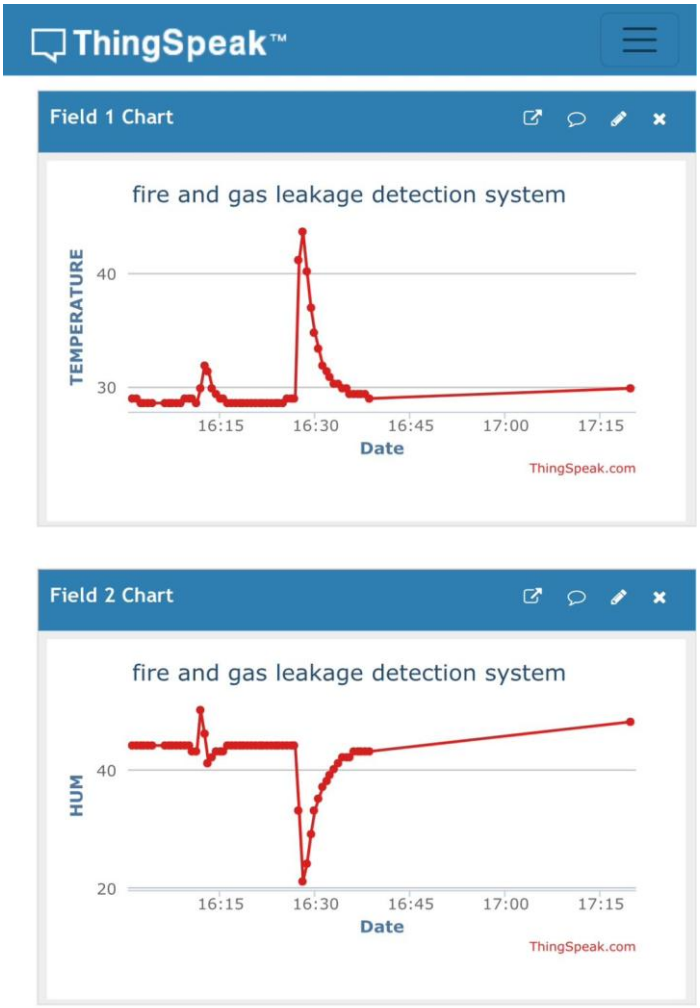

Figure 2: Temperature and Humidity Graph

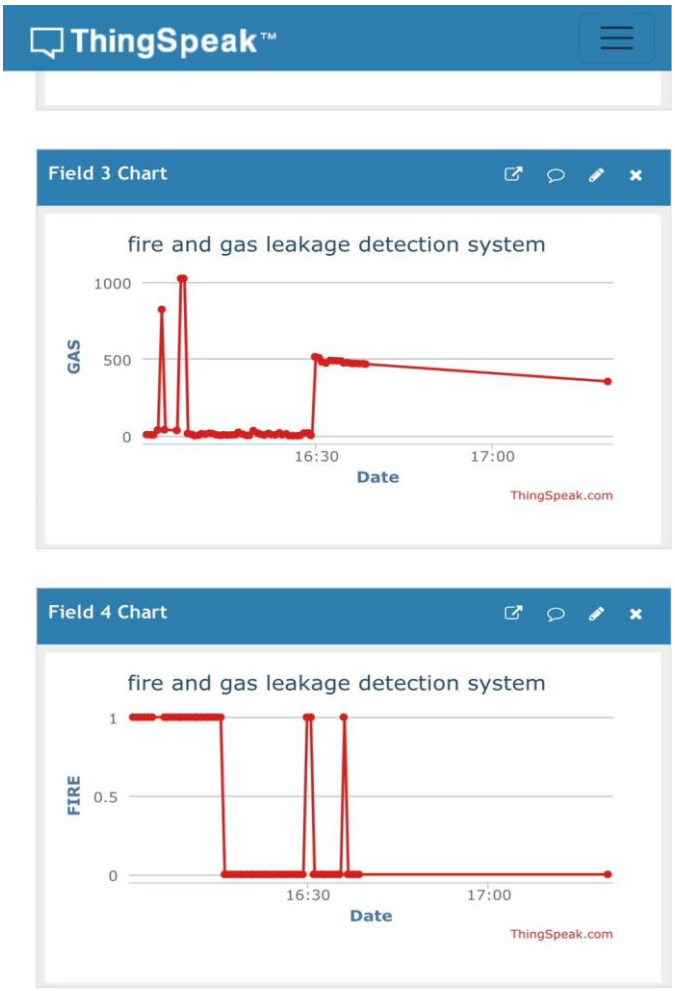

Figure 3: Gas and Fire Graph

The Figure 2 graph illustrates data from a fire and gas detection system. Notably, there is a sharp increase in both temperature and humidity around 16:30, suggesting a potential fire or gas leak event. The system likely triggered an alert during this anomaly.

The Figure 3 graph shows gas levels detected by the MQ-2 Gas Sensor, while the second graph displays fire detection events. By combining both, the system enables real-time monitoring for potential gas leaks and fire incidents, triggering alarms or safety protocols as needed.

FUTURE ADVANCEMENTS

In future IoT-based systems have revolutionized safety measures, particularly in the detection of fire and gas leaks. These systems use advanced sensor technology that can detect the slightest changes in temperature, gas concentration, and air quality, making it easier to detect potential hazards before they escalate into full-blown disasters. Moreover, the integration of machine learning algorithms can greatly enhance predictive analysis capabilities. By analyzing patterns in the data collected by sensors, these algorithms can accurately predict potential hazards with high precision. This can significantly improve the efficiency and effectiveness of fire and gas detection systems.

Further integration with smart home systems and emergency services can provide additional convenience and safety to users. For example, in the event of a fire or gas leak, the system can automatically alert the nearest fire station or emergency services, ensuring swift and timely response. Predictive maintenance is another key benefit of these systems. By constantly monitoring the system's performance, predictive maintenance can ensure optimal system conditions, thereby improving reliability and reducing downtime. This can save businesses a lot of money in the long run by reducing the number of costly repairs and replacements.

Overall, these enhancements improve the system's overall effectiveness, efficiency, and reliability, resulting in cost savings and reduced downtime. As such, IoT-based systems have become a game-changer in the field of safety measures, particularly in the detection of fire and gas leaks.

CONCLUSION

In this paper, the proposed system introduces a fire and gas detection system based on IoT, which is designed to enhance safety in industrial and residential settings. The system comprises a range of sensors such as humidity, temperature, IR, and MQ 2 gas sensors to ensure precise detection. It also employs a Wi-Fi module for internet connectivity and a buzzer to provide immediate alerts. With an LCD display that delivers real-time status updates, the system is accessible, reliable, efficient, and easy to maintain. The proposed system is a significant breakthrough in IoT technology that aims to improve public safety. Its multifaceted approach to hazard detection and the capability to remotely monitor make it a valuable addition to safety protocols. Moreover, the system's ability to scale and integrate with other smart systems promises to enhance hazard detection and prevention standards further. By leveraging IoT technology, this system addresses the need for proactive hazard detection and response in various environments. The inclusion of several sensors ensures comprehensive monitoring, while the Wi-Fi module enables remote access and data transmission. The user-friendly interface enhances usability, allowing for quick and informed decision-making during emergencies.

In summary, the proposed IoT-based fire and gas detection system is a significant advancement towards enhancing public safety. Its reliability, efficiency, and scalability make it a promising solution for real-world applications. Further research and development in this area could lead to even more advanced and effective safety systems.

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