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Smart Feast: IoT-Based Food Safety and Environmental Monitoring System Using Arduino and ESP8266

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KEYWORDS

Internet of things (iot), arduino, esp8266, thingspeak, temperature and humidity monitoring, gas detection, mq sensor, dht11 sensor.

ABSTRACT

The Smart Feast system is an IoT-based monitoring and control solution designed to improve safety, hygiene, and environmental conditions in large-scale food serving areas such as community feasts, weddings, and institutional kitchens. The system is built using Arduino as the main microcontroller for sensor data acquisition, while the ESP8266 Wi-Fi module enables wireless communication with the cloud. The collected data is uploaded to the ThingSpeak IoT platform for real-time visualization and analysis. The system incorporates a DHT11 sensor to monitor temperature and humidity levels, ensuring that food is maintained under safe environmental conditions. A gas sensor (MQ-series) is used to detect harmful gases or spoilage-related emissions, providing early detection of unsafe or unhygienic conditions. When abnormal readings are detected, a relay-controlled fan is automatically activated for ventilation and cooling, while a buzzer alarm provides immediate local warning to alert nearby users.All sensor data is transmitted through the ESP8266 module to the Thing Speak cloud platform, where it is displayed in graphical form for remote monitoring.

I. INTRODUCTION

In recent years, the rapid advancement of the Internet of Things (IoT) has enabled the development of smart systems for efficient monitoring and automation across various domains, including food service management. Large-scale food serving environments such as community feasts, weddings, and institutional kitchens often face challenges related to maintaining hygiene, ensuring food safety, and managing environmental conditions. Traditional methods rely heavily on manual supervision, which can be inefficient, time-consuming, and prone to human error.

Maintaining appropriate temperature, humidity, and air quality is essential to prevent food spoilage and ensure the safety of consumers. Unfavorable environmental conditions or the presence of harmful gases can lead to contamination, health risks, and wastage of food. Therefore, there is a need for an automated system that

can continuously monitor these parameters and provide timely alerts.

The proposed Smart Feast system addresses these challenges by integrating IoT technology with embedded systems. The system uses an Arduino microcontroller to collect data from sensors such as the DHT11 for temperature and humidity monitoring, and an MQ-series gas sensor for detecting harmful gases. The ESP8266 WiFi module enables real-time data transmission to the ThingSpeak cloud platform, allowing users to monitor conditions remotely.

In addition to monitoring, the system incorporates automation features. A relay-controlled fan is activated when abnormal environmental conditions are detected to maintain proper ventilation, while a buzzer provides immediate alerts to nearby personnel. This combination of monitoring and control ensures a safer and more hygienic food serving environment.

II. REVIEW LITERATURE SURVEY

Recent advancements in the Internet of Things (IoT) have led to the development of various smart monitoring systems aimed at improving food safety, environmental monitoring, and automation. Several research works have focused on integrating sensors, microcontrollers, and cloud platforms to create efficient and low-cost solutions.Early research focused on handcrafted feature-based methods.

Ashraf Ali Jamal Deen et al. (2023) proposed an IoT-based food quality monitoring system using Arduino and ESP8266. Their system utilized sensors such as DHT and MQ-series to monitor environmental parameters like temperature, humidity, and gas levels. The collected data was transmitted to an IoT platform for real-time monitoring, helping to maintain food quality and reduce spoilage.

Atharva Joshi et al. (2022) developed a food spoilage detection system using Arduino and ESP8266. Their work focused on detecting odor changes using gas sensors to identify spoiled food. The system sends alerts to users, ensuring timely action and reducing health risks associated with contaminated food.

M. Brahma Raju et al. (2025) designed an IoT-based smart kitchen automation and monitoring system using ESP8266. Their system integrated multiple sensors to monitor environmental conditions and control appliances through a mobile application. It provided real-time alerts for safety issues such as gas leakage and temperature variations.

Paul Stone Brown and Angel G. Meela (2021) proposed an IoT-based real-time monitoring system using Arduino and ESP8266 with ThingSpeak integration. Their system demonstrated how sensor data (such as temperature) can be uploaded to cloud platforms for remote monitoring and analysis.

Imam Riadi and Rizal Syaefudin (2021) developed an IoT-based system for monitoring and controlling temperature and humidity using ESP8266. Their work emphasized the importance of maintaining proper environmental conditions for food-related processes and demonstrated cloud-based monitoring using ThingSpeak.

Pandey A et al. (2024) presented an IoT-based home automation system using Arduino and ESP8266. Their system used relays and wireless communication to control appliances remotely, showcasing the effectiveness of IoT in automation and control applications.

III. RESEARCH METHODOLOGY

The design technology Smart Feast system is developed using a systematic approach that combines hardware integration, software implementation, and IoT-based communication to monitor and control environmental conditions in food serving areas. The system is designed to continuously observe key parameters such as temperature, humidity, and gas levels to ensure food safety and hygiene. An Arduino microcontroller is used as the central processing unit, which collects data from sensors including the DHT11 for temperature and humidity measurement and an MQ-series gas sensor for detecting harmful gases.

The collected sensor data is processed by the Arduino and compared with predefined threshold values to identify abnormal conditions. For communication purposes, the ESP8266 WiFi module is interfaced with the Arduino to transmit the data to the ThingSpeak cloud platform. This enables real-time monitoring and visualization of environmental conditions through graphical representations, allowing users to access the data remotely.

The system also incorporates automation features to respond to unsafe conditions. When the temperature or gas levels exceed safe limits, a relay module is activated to turn on a fan for ventilation and cooling.

Simultaneously, a buzzer is triggered to provide an immediate alert to nearby users. Once the environmental conditions return to normal, the system automatically deactivates the fan and buzzer.

The entire system is tested under various conditions to ensure accuracy, reliability, and proper functioning. This methodology provides an efficient and cost-effective solution for automated monitoring and control, reducing manual effort while enhancing safety and hygiene in large-scale food serving environments.

IV. PROPOSED METHODOLOGY

The proposed Smart Feast system is designed as an IoT-based automated monitoring and control system to ensure safe and hygienic conditions in large-scale food serving environments. The methodology focuses on integrating sensing, processing, communication, and control mechanisms into a single efficient system. The system architecture consists of sensors, a microcontroller unit, a communication module, and output devices that work together to monitor environmental conditions and take appropriate actions.

Initially, the DHT11 sensor and MQ-series gas sensor are deployed to continuously monitor temperature, humidity, and gas levels in the food serving area. These sensors send real-time data to the Arduino microcontroller, which processes the inputs and evaluates them against predefined threshold values. If the sensed values remain within safe limits, the system continues normal monitoring without any intervention.

When abnormal conditions such as high temperature, excessive humidity, or the presence of harmful gases are detected, the Arduino initiates control actions. A relay module is activated to switch on a fan, which helps in ventilation and maintaining a suitable environment. At the same time, a buzzer is triggered to provide an immediate alert to nearby personnel, ensuring quick response to potential hazards.

For remote monitoring, the ESP8266 WiFi module is integrated with the Arduino to transmit sensor data to the ThingSpeak cloud platform. The data is updated periodically and displayed in graphical format, enabling users to analyze environmental conditions in real time from any location. This also allows for better decision-making and preventive measures.

The proposed methodology emphasizes automation, real-time monitoring, and quick response mechanisms. By combining sensor data acquisition, wireless communication, and automated control, the system minimizes human intervention, reduces food spoilage, and enhances overall safety and hygiene. This makes it a reliable and cost-effective solution for smart food management in large gatherings.

system architecture or block diagram

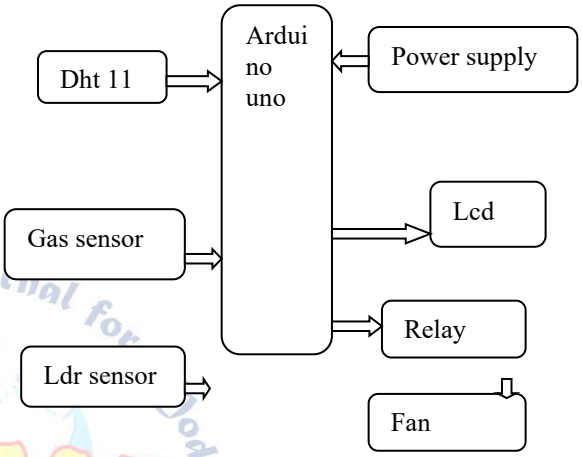

FIG. 4.1. SYSTEM ARCHITECTURE

V. RESULTS AND OUTCOMES

The implementation of the Smart Feast system demonstrates effective monitoring and control of environmental conditions in food serving areas. The system successfully collects real-time data on temperature, humidity, and gas levels using the DHT11 and MQ-series sensors. These parameters are accurately processed by the Arduino and transmitted to the ThingSpeak cloud platform via the ESP8266 module, where they are displayed in graphical format for easy analysis and remote access.

The results show that the system responds promptly to abnormal conditions. When temperature or gas levels exceed predefined thresholds, the relay-controlled fan is automatically activated to improve ventilation, and the buzzer generates an immediate alert to notify nearby users. Once the environmental conditions return to normal, the system effectively deactivates the fan and buzzer, ensuring efficient energy usage.

The integration with the ThingSpeak platform enables continuous monitoring and data logging, allowing users to track environmental variations over time. This helps

in identifying patterns and taking preventive measures to maintain food safety and hygiene.

Overall, the outcomes indicate that the proposed system reduces manual supervision, minimizes food spoilage, and enhances safety in large-scale food serving environments. The system proves to be reliable, cost-effective, and scalable, making it suitable for real-world applications such as community feasts, weddings, and institutional kitchens.

VI. CONCLUSION

The Smart Feast system presents an effective IoT-based solution for monitoring and controlling environmental conditions in large-scale food serving environments. By integrating Arduino, ESP8266, and sensors such as DHT11 and MQ-series gas sensors, the system ensures continuous monitoring of temperature, humidity, and air quality to maintain food safety and hygiene.

The implementation of automated features, including a relay-controlled fan and buzzer alert system, enables quick response to abnormal conditions, reducing the risk of food spoilage and health hazards. The use of the ThingSpeak cloud platform allows real-time data visualization and remote monitoring, improving decision-making and operational efficiency.

The results demonstrate that the system significantly reduces manual supervision while providing a reliable and cost-effective solution for smart food management. It enhances safety, minimizes wastage, and ensures a hygienic environment during large gatherings such as feasts, weddings, and institutional food services.

In conclusion, the Smart Feast system highlights the potential of IoT and embedded systems in modernizing traditional food management practices. Future enhancements can include the integration of advanced sensors, mobile applications, and AI-based predictive analysis to further improve system performance and scalability.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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