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IOT Based Meat and Fruits Freshness Detection

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Abstract - Food freshness monitoring is essential to ensure consumer safety and reduce food waste caused by spoilage of meat and fruits. Conventional methods mainly depend on visual inspection and manual checking, which are often inaccurate and inefficient. This paper presents an IoT-based system for real-time detection of meat and fruit freshness using environmental and gas sensing techniques. The proposed system employs an ESP8266 microcontroller integrated with a DHT11 sensor to measure temperature and humidity, an MQ135 gas sensor to detect spoilage-related gases, and a moisture sensor to identify surface wetness. Sensor data are continuously monitored and compared with predefined threshold values to classify the food condition as fresh, moderate, or spoiled. A buzzer is used to provide immediate alerts when spoilage is detected, while Wi-Fi connectivity enables remote monitoring through a web interface. Experimental results show that the system effectively detects freshness variations and provides timely alerts. The proposed solution is low-cost, reliable, and suitable for household, storage, and retail food safety applications.

1.INTRODUCTION

Food safety has become a significant concern due to the increasing consumption of perishable food products such as meat and fruits. These food items are highly sensitive to environmental conditions and can spoil quickly if not stored properly, leading to serious health risks and economic losses. Conventional freshness detection methods mainly depend on visual inspection, smell, or manual testing, which are subjective, unreliable, and time-consuming. With the growth of food storage facilities, transportation networks, and retail markets, there is a strong need for an automated and reliable freshness monitoring system. The Internet of Things (IoT) offers an efficient solution by enabling real-time data collection, processing, and remote monitoring. By using sensors to measure temperature, humidity, gas emissions, and moisture levels, changes related to food spoilage can be accurately identified. Microcontrollers with wireless communication capabilities allow continuous monitoring and instant alert generation without human intervention. The proposed IoT-based system integrates an ESP8266 microcontroller with multiple sensors to evaluate freshness conditions and classify food quality effectively. This approach improves food safety, reduces wastage, and provides a low-cost, scalable solution suitable for households, storage units, and retail environments.

2. Related Work

Several studies have explored food quality monitoring using sensors and embedded systems. Gas sensors have been used to detect ammonia and other spoilage gases, while temperature and humidity sensors help monitor storage conditions. However, many existing systems are expensive or lack real-time remote monitoring. The proposed system integrates multiple low-cost sensors with IoT capability to overcome these limitations.

3. System Methodology

The system continuously monitors environmental parameters around meat and fruits to evaluate their freshness in real time. The DHT11 sensor measures temperature and humidity, which directly influence the rate of food spoilage. The MQ135 gas sensor detects harmful gases such as ammonia and volatile compounds released during decomposition. The moisture sensor checks surface wetness, which increases as spoilage progresses. All sensor outputs are collected by the ESP8266 microcontroller, where the data are filtered and processed. The processed values are compared with predefined threshold limits stored in the controller. Based on this analysis, the food condition is classified into different freshness levels such as fresh, moderate, or spoiled. When abnormal values indicating spoilage are detected, an alert is immediately generated through a buzzer. Simultaneously, the sensor data and freshness status are transmitted to a web-based interface using Wi-Fi connectivity. This enables remote monitoring and real-time access to food quality information. The system operates continuously with minimal human intervention, ensuring reliable and efficient freshness detection.

4.System Design

4.1 Block Diagram

The block diagram consists of sensors connected to the ESP8266 microcontroller, Wi-Fi communication module, buzzer, and web interface.

4.2 Hardware Description

ESP8266: Controls the system and enables Wi-Fi connectivity
*DHT11: Measures temperature and humidity
*MQ135: Detects spoilage gases
*Moisture Sensor: Detects wetness on food surface
*Buzzer: Provides alert indication

4.3 Software Description

The system is programmed using Arduino IDE. Sensor data are processed using embedded C code, and a web server is created for real-time monitoring.

5.Applications

The proposed IoT-based freshness detection system can be applied in various real-world scenarios to improve food safety and quality monitoring. It can be used in households to monitor stored meat and fruits and prevent the consumption of spoiled food. The system is suitable for cold storage units and warehouses where continuous freshness monitoring is required. Supermarkets and retail shops can use the system to ensure the quality of food products before sale. It can also be implemented in food transportation and supply chain management to track freshness during transit. Restaurants and food processing

industries can benefit from real-time monitoring to maintain hygiene standards and reduce food wastage.

6.Results and Discussion

The system was tested with meat and fruit samples under different conditions. Fresh food showed low gas concentration and normal moisture levels, while spoiled food showed increased gas values and moisture. The system successfully detected spoilage and generated alerts. The results confirm the accuracy and reliability of the proposed method.

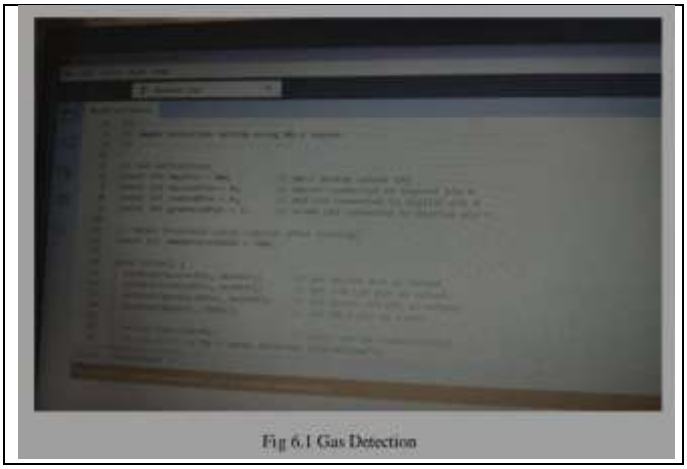

Fig 6.1 Gas Detection

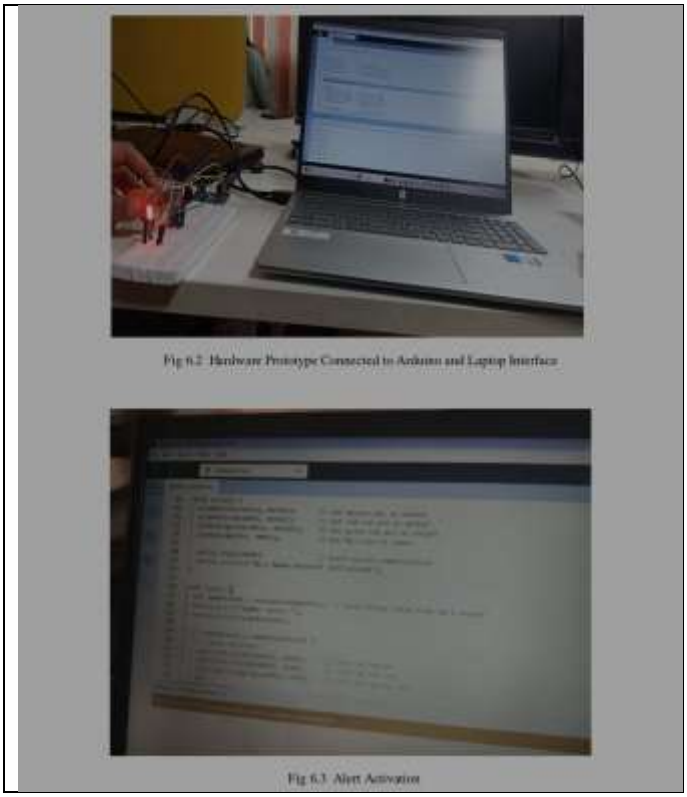

Fig 6.2 Hardware Prototype Connected to Arduino and Laptop Interface

Fig 6.3 Alert Activation

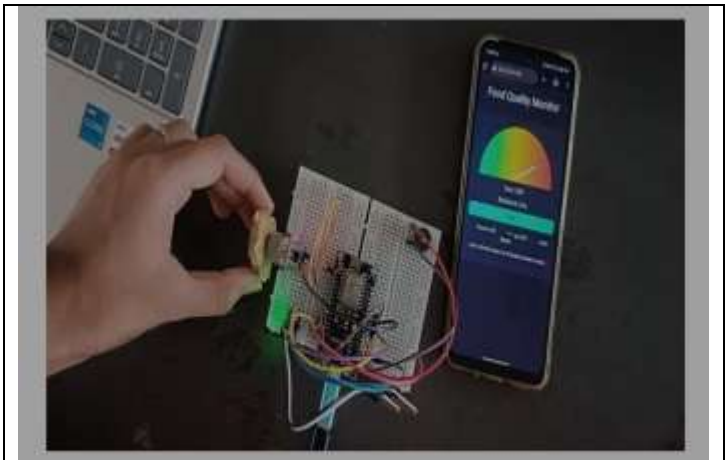

Fig 6.4 Food Spoilage Detection During Integration and Testing Phase

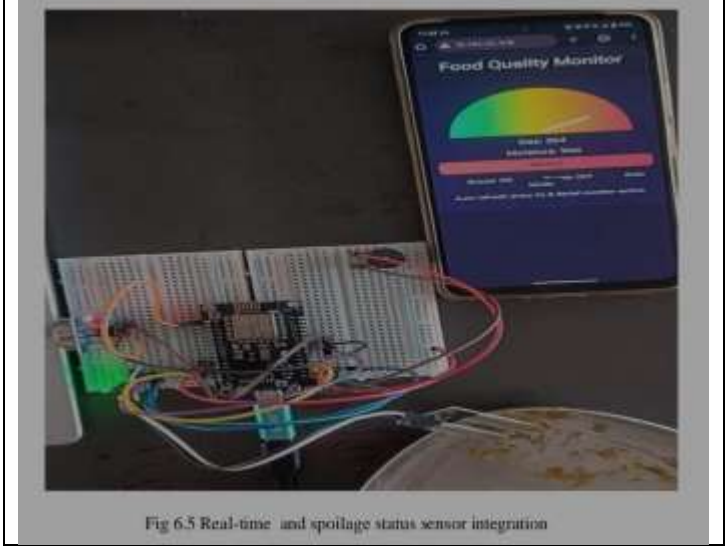

Fig 6.5 Real-time and spoilage status sensor integration

7.Advantages

The proposed system offers several advantages over traditional freshness detection methods. It provides real-time monitoring of food quality without manual inspection. The system is low cost and uses easily available sensors, making it affordable and practical. It offers remote access through a web interface using IoT technology. Instant alerts help in taking timely action to prevent food spoilage. The system is easy to install and operate with minimal maintenance. It reduces food wastage and health risks. The design is scalable and can be extended to monitor different food items. Overall, the system improves food safety and operational efficiency.

8.Conclusion

This paper presented an IoT-based system for monitoring the freshness of meat and fruits using multiple sensors and wireless communication. The proposed system integrates an ESP8266 microcontroller with temperature, humidity, gas, and moisture sensors to detect spoilage conditions in real time. By continuously analyzing sensor data and comparing it with predefined threshold values, the system effectively classifies food quality as fresh, moderate, or spoiled. Instant alerts and remote monitoring through a web interface enhance timely decision-making and reduce reliance on manual inspection. Experimental results demonstrate that the system provides reliable and accurate freshness detection. The proposed solution is cost-effective, scalable, and easy to implement, making it suitable for households, storage facilities, and retail environments. Overall, the system improves food safety,

minimizes health risks, and helps reduce food wastage through efficient freshness monitoring.

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