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IOT BASED FOOD DEGRADATION DETECTION SYSTEM

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Abstract— **This paper presents an Internet of Things (IoT) - based system for Smart Food Degradation Detection using an ESP32 microcontroller integrated with temperature, humidity, and gas sensors. The system continuously monitors environmental factors that influence food degradation and sends real-time data to Firebase for storage and analysis. A web- based interface is developed to display sensor data, providing a live dashboard with real-time updates on food conditions. Automated decision-making algorithms trigger alerts when spoilage is detected based on predefined sensor thresholds. The system can send notifications via SMS and email. This IoT- based technology provides a cost-effective and efficient substitute for manual, conventional food inspection techniques by utilizing cloud storage for previous data. The suggested solution seeks to minimize waste and improve food storage procedures while giving businesses useful information about food quality and spoiling detection.**

Keywords—**IoT, food degradation, sensor-based monitoring, Firebase, automated alerts, ESP32, cloud storage, spoilage detection, web dashboard**

I. INTRODUCTION

Food spoilage is a significant issue in the food industry, leading to economic loss, waste, and health risks. Traditional methods of detecting food degradation, such as visual inspection, chemical testing, and smell tests, are often subjective and inefficient. The rise of Internet of Things (IoT) technology offers a promising solution to this problem by integrating sensors with cloud-based data storage and realtime monitoring systems.

This paper proposes an IoT-based system for Smart Food Degradation Detection, which utilizes temperature, humidity, and gas sensors to monitor the environmental conditions that contribute to food spoilage. The data is sent to Firebase for cloud storage and analysis, while a web-based interface allows users to monitor food conditions in real time.

II. SYSTEMDESIGN

A. Hardware Set-up

In Fig.1 Hardware of Smart Food Degradation Detection system based on IoT is centered on an ESP32 microcontroller, which is the processor. Microcontroller talks to other sensors like the DHT11 or DHT22 temperature and humidity sensor and the MQ-135 gas sensor. DHT11/DHT22 sensors are used always to monitor temperature and humidity within the food storage unit because they play a vital role when dealing with food spoilage.

MQ-135 sensor is utilized to detect carbon dioxide and ammonia gases that serve as food spoilage markers and indicatorsofmicrobialcontamination.ESP32storesthesensor values and uploads them to the Firebase cloud for live processing and storage. It is equipped with ground feedback through OLED display, by which actual measurements of temperature, humidity, and gas content are monitored directly.

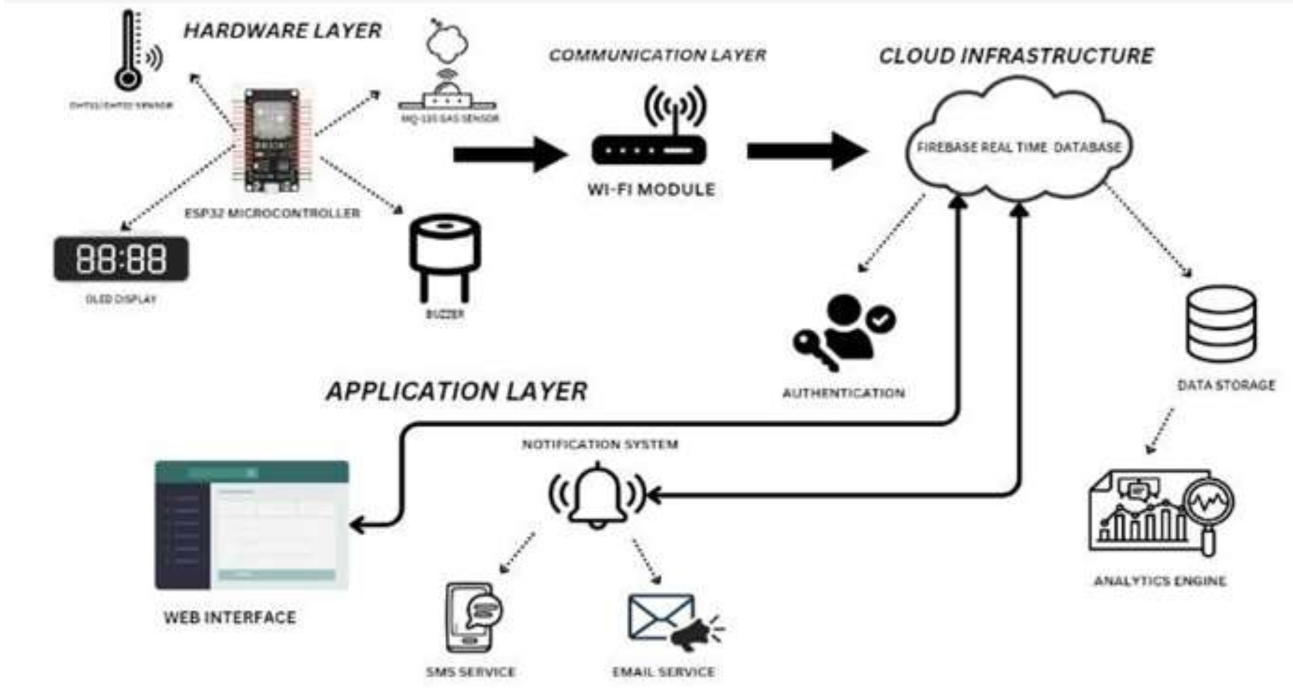

Fig.1. Architecture for proposed Approach

B. Workflow –

The Smart Food Degradation Detection system begins with data collection. The system is based on the use of DHT11/DHT22sensorstocollecttemperatureandhumidityin real-time continuously, and the MQ-135 sensor to collect gases that are characteristic of spoilage, such as carbon dioxide and ammonia. The environmental data is collected in real-time, and it provides a real-time reading of the environment surrounding the stored food. Accurate and timely data collection is required for the system to respond in real- time to environmental changes that may indicate impending spoilage.

Data transmission follows data collection. The ESP32 microcontroller sends the data to the Firebase Real time Database through its onboard Wi-Fi module. This enables seamless, real-time uploading of data to the cloud where it is stored and accessed remotely. Firebase technology offers real- time updating of data and offers the data for further processing and analysis so that the users are able to monitor the status of the food storage conditions at any point of time from anywhere.

The system moves towards the decision level. The sensed information from the sensors is cross-verified with set threshold levels signifying the storage conditions for safe storage. As soon as one of the parameters that are being monitored exceeds these levels, which means there is a possibility of spoilage, the system determines that it must automatically issue notifications. Through this, no human action is needed, which helps in quicker detection and action against food spoilage and preventing chances of spoilage remaining undetected for longer durations.

Finally, notification mechanisms are initiated. When spoilage is detected, the system produces multiple types of alerts to inform the user in real-time. The alerts are sent via SMS, email, and web-based alert. Locally, there is a buzzer, and there are visual cues on an OLED display that provide users with instant feedback of the food status. Alarms are a multi-channel-based alert system, which notifies users of potential conditions for spoilage and enables action to avoid subsequent deterioration. Workflow is also enabled by implementing a web-enabled dashboard, which updates automatically with trends and forecasts of conditions in the environment and enables effective management of food storage.

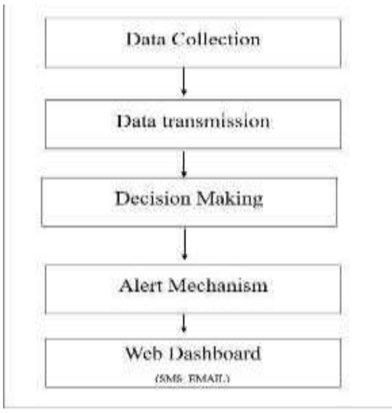

Fig.2. Architecture diagram for Workflow

III. EXPERIMENT ANDRESULT

The User Login Fig 3 has the user authentication module of the "Food Spoiler Detection" system offers a simple and secure method for users to login to the system. The login page is made as simple as possible with username and password fields. The page has a humongous light orange title that immediately grabs the user's attention and makes the functionality of the system easily visible.

The green highlighted "Login" button provides uncooked interaction and enables instant access to the system upon configuration of authentication credentials. The secure logon process prevents unauthorized users, whether they are employees or other users, from viewing or altering food spoilage detect data and thus avert leakage of sensitive contents and violation of confidentiality.

Fig.3.User Login

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In the Smart Food Degradation Detection Dashboard Fig 4.After successful login, the users are transferred to the Smart Food Degradation Detection dashboard where the sensor readings in readable and simple format are shown real time. The dashboard shows critical information like temperature, humidity, and gas levels being tracked real time by the IoT system. These values are given in meter or gauge form so that users can simply find out whether the food is safe to store.

It is to identify when food has expired. Color-coded message and food emojis dynamic food status update is a friendly interface, visual sense to the process of monitoring. By doing this, even the non-technical users are able to view the data directly at a glance and react accordingly when needed. Apart from revealing real-time sensor readings, the dashboard also offers functionality to reveal instant action in case of spoilage found.

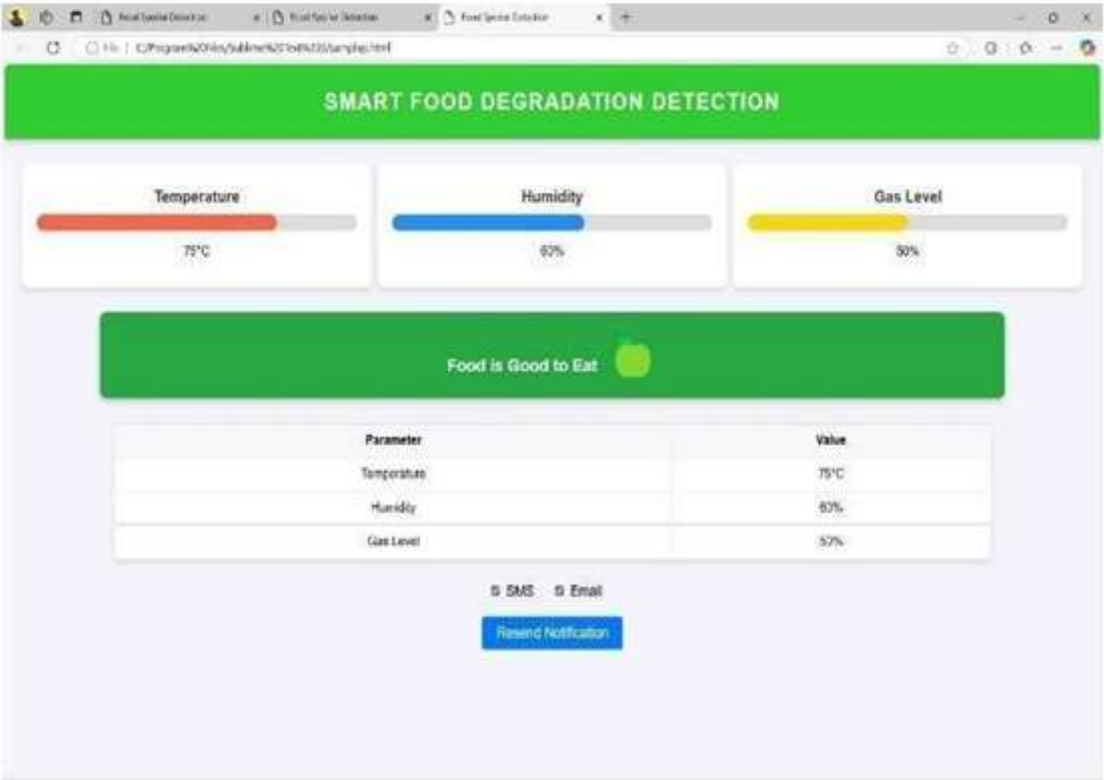

Fig.4.Smart Food Degradation Detection Dashboard

The Smart Food Degradation Detection dashboard Fig 4 for example, users can initiate alert through mail or SMS to inform stakeholders or initiate remedial action. The ability serves system responsiveness as well as the timely notification of users to outstanding changes in the condition of food storage.

The system, via the integration of user-triggered alert with machine sensing, ensures a certain forward-looking approach towards food safety guarantee. The IoT solution seeks to transform food preservation processes through automating spoilage detection, the potential of which lies in minimization of wastage of foods as well as food safety and quality management as a whole.

IV. CONCLUSION

In conclusion, the Internet of Things-based food spoilage detection system is a reliable and effective way to detect the spoilage status at an early stage and start real-time monitoring of food quality. It alerts through employing the cloud storage of Firebase at an extremely fast pace based on real-time surveillance using sensors on key parameters like temperature, humidity, and the production of decay-related gases. The cloud-based system enables automatic synchronization of data and remote access, which facilitates users in easier monitoring and acting upon food quality problems. Incorporating a web-based dashboard that is simple to use also enhances access, with real-time sensor readings visually presented, e.g., warning or condition indicators, supporting users in taking rapid decisions.

Scalability of the system gives the potential to deploy it in small- and large-scale applications, and an economical and flexible solution will be available for various food storage and distribution setups. Detection algorithms will keep evolving to provide better precision in the years to come, and additional sensors will be integrated to identify more spoilage markers.

By doing so, the system will be best positioned to prevent food wastage, maintain food safety, and provide both consumers and enterprise with an authoritative platform for ensuring food quality in real-time, encouraging more ethical food industry practices

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