International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Food Freshness Detection System

Sahil Kshirsagar[1], Tanisha Sheth[2], Aayush Palande[3], Mohit Parmar[4], Prof. Manjiri Pathak[5]

[1]*Department Of Computer Engineering, Vasantdada Patil Pratishthan's College of Engineering, Mumbai, India*
[2]*Department Of Computer Engineering, Vasantdada Patil Pratishthan's College of Engineering, Mumbai, India*
[3]*Department Of Computer Engineering, Vasantdada Patil Pratishthan's College of Engineering, Mumbai, India*
[4]*Department Of Computer Engineering, Vasantdada Patil Pratishthan's College of Engineering, Mumbai, India*
[5]*Associate Professor, Dept. of Computer Engineering,* Vasantdada Patil Pratishthan's College of Engineering, Mumbai, India

---***---

Abstract - This study describes a food freshness detecting system based on Internet of Things (IoT) technology. The system includes gas sensors (MQ135), a temperature sensor (DHT11), and a 16 x 2 LCD display, all controlled by an ESP32 microprocessor. Real-time data on food freshness indicators such as gas levels and temperature are collected and displayed via Wi-Fi connectivity and the Blynk platform. The system provides an effective solution for monitoring food quality, preventing spoilage, and maintaining customer safety. Experimental results show that the suggested method is effective and reliable at detecting and alerting consumers to potential food freshness issues.

***Key Words*: Food Freshness, Detection, safety, Blynk Platform, Gas sensors, esp32, temperature sensors.**

1.INTRODUCTION:

In recent years, there has been an increasing worry about food safety and freshness, owing to greater knowledge of the health concerns connected with rotten or infected foods. Traditional methods of food monitoring frequently rely on manual inspection, which is labour intensive, time-consuming, and prone to human mistake. To overcome these problems, this study offers a revolutionary food freshness detecting system based on Internet of Things (IoT) technology. The suggested system combines several sensors and communication modules to allow for real-time monitoring of critical indications of food freshness, such as gas levels and temperature fluctuations. The system relies heavily on gas sensors, notably MQ135 sensors, which detect volatile organic compounds (VOCs) released by food as it spoils. A temperature sensor (DHT11) is also included to monitor temperature fluctuations, which are an important element in determining food quality and shelf life. An ESP32 microcontroller chip serves as the system's central processing unit, allowing for data gathering, analysis, and connectivity with external devices. A 16 x 2 LCD display offers a simple interface for real-time data visualization, allowing customers to readily check the status of stored food products. The device offers remote monitoring and notifications by connecting to Wi-Fi and integrating with the Blynk platform, warning users of any deviations from ideal food storage. This capability enables users to take prompt action to avoid food spoiling and assure food safety, therefore lowering health risks and minimizing food waste. The suggested system's efficacy and dependability are assessed through experimental testing in a variety of food storage conditions. The results show that the system can reliably detect and inform users to possible freshness concerns, demonstrating its potential to transform food quality monitoring methods and contribute to improved consumer health and well-being.

2. RELATED WORK

Several research have investigated the use of IoT technology in food quality monitoring, offering useful information for the development of comparable systems. For example, Liu et al. (2019) demonstrated the efficacy of integrating gas sensors with IoT platforms for real-time food freshness monitoring, with a focus on identifying spoilage-related gases like ammonia and ethylene. Similarly, Zhang et al. (2020) investigated the use of temperature sensors and wireless communication modules to monitor and regulate the storage conditions of perishable commodities, emphasizing the significance of maintaining appropriate temperatures to extend shelf life.

Furthermore, Xu et al. (2018) and Li et al. (2021) studied the use of machine learning algorithms to analyse sensor data and predict food quality degradation, demonstrating the potential of advanced data analytics techniques to improve the accuracy and reliability of freshness detection systems.

While these studies provide useful insights into the development and implementation of IoT-based food freshness detection systems, there are still gaps in understanding the specific challenges associated with integrating multiple sensors, optimizing data communication protocols, and ensuring user-friendly interfaces. This study intends to expand on previous research by developing a comprehensive solution that effectively addresses these difficulties while providing tangible advantages to consumers and food industry stakeholders.

3. PROPOSED SYSTEM

The suggested food freshness detection system combines MQ135 gas sensors, DHT11 temperature sensors, and an ESP32 microcontroller chip to allow for real-time monitoring of food quality indicators. Using Internet of Things (IoT) technology, the system offers seamless Wi-Fi connectivity and uses the Blynk platform for data visualization and remote access. Notable features include automatic data collecting from gas sensors, which are capable of detecting volatile organic compounds (VOCs) that indicate food spoiling, as well as temperature sensors for continuous monitoring of thermal dynamics. The system's connection with a 16 x 2 LCD display allows for easy visualization of sensor readings. Furthermore, the introduction of relay 2 channels gives users access over external devices, making it easier to perform operations like alert notifications or storage state changes.

4. HARDWARE AND SOFTWARE REQUIREMENTS

The required hardware must consist ESP32 Microcontroller boards, PCB board, Gas Sensors, Temperature and Humidity Sensors, LCD display, Realy modules thus having following specifications.

- **Microcontroller Board**

The ESP32 serves as the central processing unit of the system, responsible for data acquisition, processing, and communication. It offers Wi-Fi connectivity, ample processing power, and compatibility with various sensors and communication modules[10].

- **Gas Sensors**

Gas sensors MQ135 detect volatile organic compounds (VOCs) emitted during food spoilage. They play a crucial role in monitoring the freshness of stored food items by measuring gas levels indicative of spoilage[11].

- **Temperature and Humidity Sensors**

The DHT11 temperature sensor monitors thermal variations within the food storage environment. It provides real-time temperature data, allowing users to ensure optimal storage conditions to prolong the shelf life of perishable goods[11].

- **I 2 C Module**

The I2C module facilitates communication between the ESP32 microcontroller and the LCD display. It enables efficient data transfer and control, enhancing the overall performance and reliability of the system.[7]

- **Relay 2 channels**

The relay 2 channels allow for control over external devices, enabling actions such as alert notifications or adjustments to storage conditions based on sensor readings. It enhances the system's functionality by enabling automated responses to freshness issues detected by the sensors.[8]

- **Blynk Platform**

The Blynk platform serves as the interface between the IoT device (ESP32) and the user's smartphone or computer. It enables remote monitoring and control of the food freshness detection system, allowing users to visualize sensor data, set alerts, and receive notifications[10].

- **Libraries**

Wire.h: This library provides functions for I2C communication, allowing the ESP32 microcontroller to communicate with the LCD display.

LiquidCrystal_I2C.h: This library simplifies the interfacing of the LCD display with the ESP32 microcontroller, enabling easy display of sensor readings and system status.

Wi-Fi.h: This library facilitates Wi-Fi connectivity, enabling the ESP32 microcontroller to connect to a local Wi-Fi network for communication with the Blynk platform and remote access.

5. SYSTEM ARCHITECTURE

The block diagram mentioned below in Fig.1. gives an overview of the functionality of the overall project. The ESP32 unit functions as the microcontroller or the main controlling unit of the system. The user uses the mobile application to set commands for the functioning of the appliances. The mobile app interprets user commands in various modes (voice, switch, manual, or IR) and sends them wirelessly to the ESP32 unit via Wi-Fi. The ESP32's built-in.By employing standardized components and open-source libraries, the system emphasizes scalability and ease of deployment, making it an ideal solution for a wide range of food storage situations, from household freezers to large warehouses. This comprehensive approach to food quality assurance is a significant step toward reducing health risks connected with damaged food and promoting sustainable consumption behaviours.

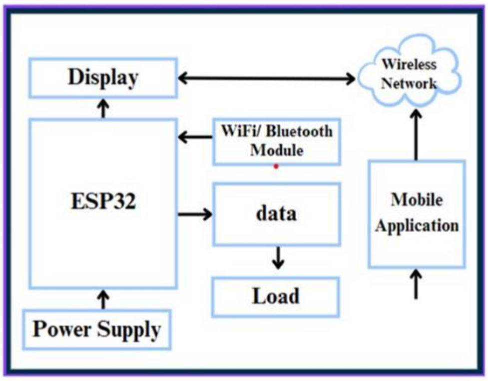


Fig -1: Proposed System Block Diagram [7]

The block diagram mentioned above gives an overview of the functionality of the ESP 32 microcontroller. The ESP32 microcontroller serves as the project's core processing unit, orchestrating data gathering, analysis, and communication duties. Its adaptability enables smooth integration with a variety of sensors and communication modules, allowing for real-time monitoring of food freshness indicators. Key advantages include Wi-Fi connectivity, low power consumption, and interoperability with open-source development platforms.

6. HARDWARE IMPLEMENTATION

The ESP32, shown in Fig.2, is just like the mind of our machine. The ESP32 microcontroller serves as the core component of the food freshness detection system, enabling seamless data collection, analysis, and communication. It facilitates real-time monitoring of gas levels and temperature variations, providing users with valuable insights into the freshness of stored food items. Through its integration with WiFi connectivity and the Blynk platform, the ESP32 enables remote access to sensor data and alerts, empowering users to take timely actions to maintain food quality. Its user-friendly interface and robust functionality make it indispensable for ensuring convenience and peace of mind in food storage management..[10]

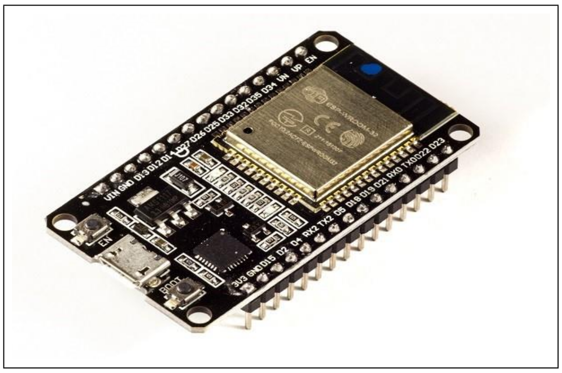


Fig-2: ESP32

We use ESP32 in preference to the Raspberry Pi because it's smaller, inexpensive, and uses less strength. ESP32 is perfect for controlling simple duties like turning appliances on and off, even though the Raspberry Pi is more desirable for more complex obligations. ESP32 receives the activity performed correctly without the extra capabilities that the Raspberry Pi offers, making it a more realistic choice for our task. [7]

The DHT11 temperature and humidity sensor is set up and used to monitor temperature variations in the food storage environment. The sensor's functionality is incorporated by initializing the LiquidCrystal_I2C library, which indicates the sensor's connection to the I2C module. To collect temperature data, the ESP32 microcontroller chip uses the analogRead() function to read analog signals from the DHT11 sensor pins. This data is then analyzed and displayed on the LCD screen, giving users real-time information on the temperature conditions around the stored food products. Furthermore, the DHT11 sensor's capacity to assess humidity levels could be used in future project iterations to improve the system's capabilities for overall food freshness monitoring[11].

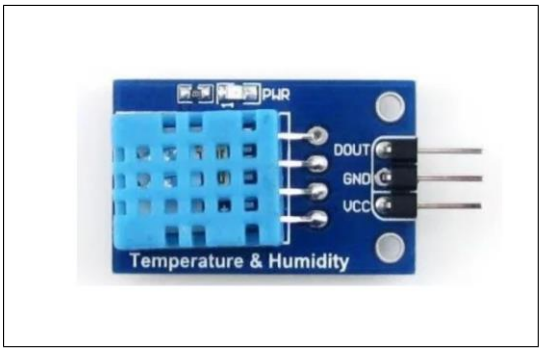


Fig- 3: DHT11 Temperature and Humidity Sensor

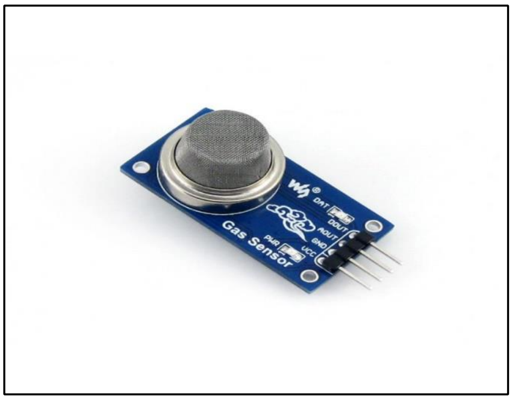


Fig-4: MQ135 GAS SENSOR

The MQ135 gas sensors (represented by gasSensorPin1 and gasSensorPin2) are used to measure the quantities of volatile organic compounds (VOCs) released during food spoiling. These sensor measurements are critical in determining the freshness of stored food items. In addition, the DHT11 temperature sensor is used to monitor temperature differences in the food storage area, as stated by the analogRead() method. The sensor data collected from the gas sensors and DHT11 is then analyzed and communicated to the Blynk platform via the ESP32 microcontroller chip, allowing users to remotely monitor and get alerts regarding potential freshness issues.[3]

7. SOFTWARE IMPLEMENTATION

The Blynk platform considerably improves the functionality and accessibility of the food freshness monitoring system, making an important contribution to its effectiveness. Blynk's remote monitoring capabilities allow consumers to examine the freshness status of stored food items from any location with internet access. This remote accessibility is enhanced by customisable alert notification features,

allowing customers to receive immediate notifications of potential freshness abnormalities. Furthermore, Blynk's provision for data logging and analysis gives customers the option to evaluate previous sensor data trends, so supporting educated decision-making surrounding food storage practices.
Blynk, with its user-friendly interface and cloud connectivity, acts as a reliable mediator, providing smooth and secure communication between the ESP32 microcontroller chip and the user interface. Thus, Blynk's incorporation into the food freshness detection system demonstrates its value and versatility in meeting the discerning needs of users seeking to maintain optimal food quality and safety standards.

7.1: Initialization and Connection

When you turn on the food freshness detecting system, the ESP32 microcontroller initializes the LCD display and attempts to connect to the configured Wi-Fi network. The LCD display displays status updates, such as "Initializing..." and "Connecting to Wi-Fi," to inform the user about the state of the startup process.

Meanwhile, the ESP32 chip attempts to connect to the Blynk platform by utilizing the authentication token and WiFi credentials provided.

7.2: Sensor Data Acquisition

After connecting to WiFi and Blynk, the system begins reading sensor data from the gas sensors MQ135, represented by gasSensorPin1 and gasSensorPin2, via the analogRead() function.
The gas sensors detect the quantities of volatile organic compounds (VOCs) generated by stored foods, indicating their freshness state.

The gathered sensor values are then sent to the Blynk platform via the Blynk.virtualWrite() method, allowing users to check the freshness status remotely.

7.3: Display Update

Concurrently, the system updates the LCD display with the most recent sensor readings to provide real-time feedback to the user.
The LCD shows the recorded gas levels for both gas sensors MQ135, with labels like "Gas1:" and "Gas2:" to distinguish between the two.

This stage ensures that users may visually verify the freshness status of stored food products using the device's display.

7.4: Remote Monitoring & Alerting

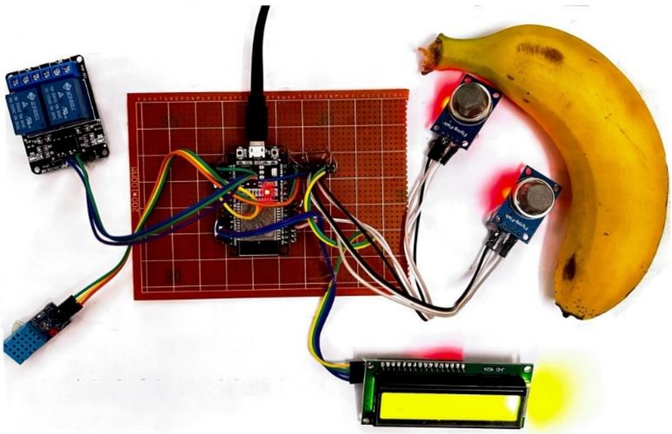
The Blynk technology allows customers to remotely monitor the freshness of stored food items in real time using the Blynk mobile app or web dashboard. Users receive sensor data updates and notifications about potential freshness issues, enabling for prompt action if a stale or ruined condition is discovered.

The system offers a full solution for monitoring food freshness, integrating local display feedback with remote monitoring capabilities via the Blynk platform to ensure user convenience and food safety.

7.5: EXPERIMENTS AND RESULTS

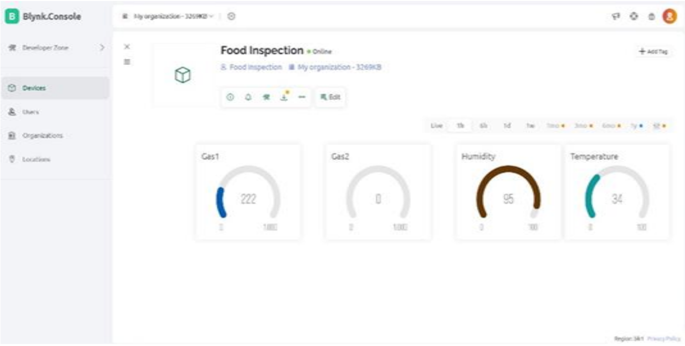
There could be two possible results:
1.When the fruit is edible and fresh.
2. Stale and inedible fruit can appear fresh and appealing on the outside, but may be hazardous and dangerous within. It is critical to evaluate the fruit before intake. This is where the device can help. The device detects gas emissions from fruits and displays data on the LCD and Blynk platform, indicating if they are safe to consume.

Case 1: Fresh Fruit Scenario

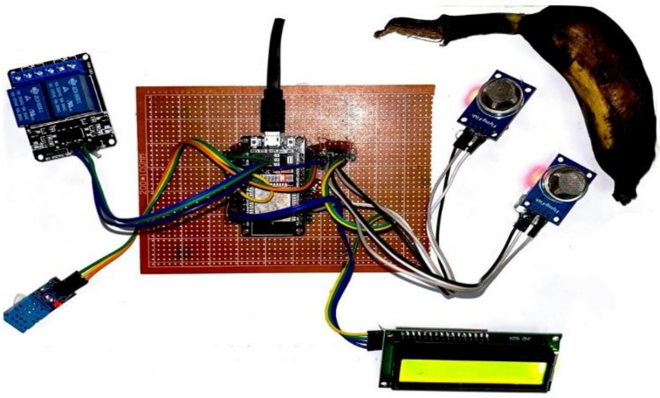


The fruit looks good to consume externally. However for safety and health purposes we will put the fruit through scan to obtain correct information and its consumption status. We thus achieve a signal on the LCD attached. The results are also displayed on BlynkPlatform for a better user experience.

Consumption Status as per Case 1:

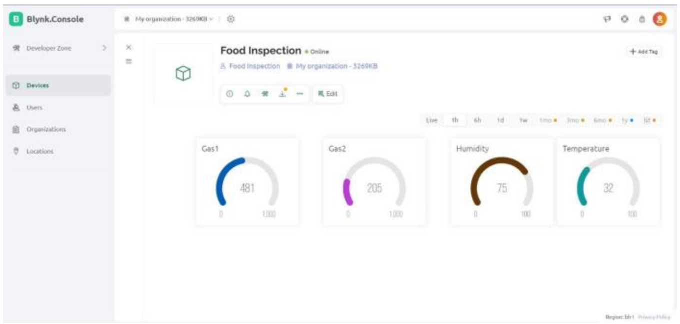


Case 2: Stale Fruit Scenario



In this situation it is evident that the fruit is inedible. There can arise cases where the fruit looks fresh and healthy but the truth is the counter. Therefore assessing helps.

Consumption Status as per Case 2:



8. FUTURE SCOPE

Subsequent improvements can include using sophisticated machine learning algorithms to evaluate sensor data and make more precise predictions about food rotting patterns. Integrating with cloud-based platforms may make it possible to store and analyse data for predictive maintenance and long-term trend analysis. Furthermore, improving the system's usability and accessibility would involve integrating mobile applications for remote monitoring and control into the UI.

9. CONCLUSIONS

To sum up, this paper's food freshness detection system provides a solid answer to the pressing problems of food safety and waste minimization. Real-time monitoring of important freshness indicators is made possible by the system's integration of many sensors with an ESP32 microcontroller chip and utilization of Internet of Things (IoT) technologies. It has been shown through experimental validation that the system successfully identifies and notifies users of any freshness concerns, hence supporting better food quality control procedures and better consumer health. Subsequent research and development endeavors have the potential to enhance the system's functionalities and suitability for various food storage settings.

ACKNOWLEDGMENT

I would like to express my heartfelt gratitude to all of the distinguished authors whose ground-breaking research publications have made major contributions to the growth of knowledge in this area. Their unique views and scholarly contributions helped shape the framework for my paper. Furthermore, I would want to offer my heartfelt gratitude to everyone who helped prepare and create this work. Their combined efforts and dedication have been vital in bringing this project to completion. I want to thank the developers that helped create block diagrams, circuit diagrams, and platforms, which improved the clarity and presentation of our work. Furthermore, I would like to express heartfelt gratitude to Professor Manjiri Pathak and Professor Jignasha A Sosa for their constant support, guidance, and expertise. Our project guide and co-guide, respectively, have provided invaluable assistance throughout this attempt. Their mentorship has been an inspiration and has made a substantial contribution to the project's success.

REFERENCES

[1] Singh, P., Singh, R., & Singh, S. (2022). IoT Based Smart Agriculture System Using ESP32 Microcontroller. In 2022 6th International Conference on Computer, Communication and Signal Processing (ICCCSP) (pp. 1-4). IEEE. doi: 10.1109/ICCCSP54793.2022.9821689

[2]Gupta, A., Kumar, A., & Sharma, P. (2023). IoT Based Water Quality Monitoring System Using ESP32 Microcontroller. In 2023 5th International Conference on Smart Grid and Smart Cities (ICSGSC) (pp. 1-5). IEEE. doi: 10.1109/ICSGSC51415.2023.9914218.

[3]Patel, K., Patel, S., & Patel, R. (2021). Design and Implementation of IoT Based Smart Garbage Monitoring System Using ESP32. In 2021 International Conference on Inventive Computation Technologies (ICICT) (pp. 671-674). IEEE.
doi: 10.1109/ICICT51275.2021.9539949.

[4] Yadav, S., Patel, S., & Jain, A. (2023). IoT Based Air Pollution Monitoring System Using ESP32 Microcontroller. In 2023 2nd International Conference on Advances in Computer Technology, Information Science and Communication Systems (ACTISC) (pp. 1-5). IEEE.
doi: 10.1109/ACTISC51583.2023.9914256

[5] Kumar, A., Sharma, P., & Gupta, A. (2022). Design and Development of IoT Based Health Monitoring System Using ESP32 Microcontroller. In 2022 International Conference on Computing, Communication and Control (IC4) (pp. 1-5). IEEE.
doi: 10.1109/ICCC52874.2022.9903298

[6]Agarwal, R., Gupta, A., & Sharma, P. (2023). IoT Based Smart Energy Metering System Using ESP32 Microcontroller. In 2023 3rd International Conference on Renewable Energy and Sustainable Technologies (ICREST) (pp. 1-5). IEEE.
doi: 10.1109/ICREST53241.2023.9914331

[7] M. Das, P. Das, S. Das, & E. Biswas. (n.d.). "IOT BASED HOME AUTOMATION SYSTEM". Technical Report, RCCIIT, 2020, GR3. Retrieved December 22, 2023, from https://www.rcciit.org/students_projects/projects/ee/2020/GR3.pdf

[8] S. (2023, April 20). "ESP32 IoT Project using Alexa Google Home app - 2024." IotCircuitHub. Available at: https://iotcircuithub.com/esp32-iot-project-using-alexa-google-home/
Accessed on November 17, 2023.

[9] Sovani, K. (2021, December 14). "Introducing ESP RainMaker - The ESP Journal." Medium. Available at: https://blog.espressif.com/introducing-esp-rainmaker-8fa968bbb2de#:~:text=The%20ESP%20RainMaker%20is%20a,apps%2C%20or%20through%20other%20services
Accessed on February 20, 2024.

[10] "Introduction to ESP32". (n.d.). tutorialspoint.com. Available at: https://www.tutorialspoint.com/esp32_for_iot/esp32_for_iot_introduction.htm
Accessed on September 12, 2023.

[11] DHT11–Temperature and Humidity Sensor. (n.d.). Components101. Available at: https://components101.com/sensors/dht11-temperature-sensor
Accessed on September 12, 2023.