

Research Article

## Novair : IoT- Based Food Freshness Tracker

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technology

**Abstract:** Food waste can be triggered by the incapacity to keep an eye on food kept in conventional refrigerators. By combining Internet of Things (IoT) technology with gas technology (sensors), automated air circulation, and RFID (Near Field Communication) inventory control systems, Novair's solution offers an integrated framework for detecting spoilage conditions and raising awareness of the situation by sending notifications via a mobile app. The results of the investigation demonstrate that Novair's technology effectively detects spoiling, enhances consumers' general knowledge of the conditions of their items, reduces waste, and enhances food safety.



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### 1. INTRODUCTION

Food waste and food safety remain major concerns in household and small food service environments, largely due to the lack of effective monitoring of food freshness during storage. Conventional refrigerators primarily rely on temperature control and provide limited information about the actual condition of stored food, making early spoilage detection difficult. Consequently, hidden food decay often goes unnoticed, leading to unnecessary waste, economic loss, and potential health risks.

Recent advancements in Internet of Things (IoT) technologies have enabled smarter food storage solutions through real-time sensing, connectivity, and automation. Gas emission analysis, in particular, is effective in detecting volatile compounds released during food decomposition, allowing earlier identification of spoilage compared to visual inspection alone.

To address these challenges, Novair is proposed as an IoT-based food freshness tracking system designed to enhance refrigerator functionality. The system integrates gas, temperature, and humidity sensors with automated air circulation and RFID/NFC-based inventory tracking. Real-time

data and alerts are delivered through a mobile application, enabling users to monitor food conditions remotely. By prioritising food safety and waste reduction, Novair offers a practical and intelligent solution for modern food storage management

## 2. LITERATURE REVIEW

In the past, refrigerators were created to keep food cold. However, as previously said, there is only a limited amount of insight into what is occurring with the biological state (quality) of the stored products, as opposed to monitoring the biological status of the things in the refrigerator. Because of this, there is a significant amount of food waste because individuals are frequently ignorant of hidden rot. Thankfully, developments in the Internet of Things (IoT) have made it possible to track food in real time by utilizing sensors to detect freshness. This section will go over the history of smart refrigerator design as well as the current technologies (such as gas sensors) used to check for food spoiling.

According to academics, smart appliances should now concentrate on their potential benefits to households rather than using large exterior screens for entertainment. Additionally, contemporary smart appliance systems may employ internal sensors to check spoiling instead of relying mostly on external interfaces. For instance, a recent study by Gallego-Serrano et al. (2023) suggests that volatile organic compounds' (VOC) detection will preserve food more effectively than temperature alone. This suggests that in order to significantly reduce home waste, smart refrigerators will depend on autonomous sensing capabilities as technology advances (Tan & Wong, 2021).

Furthermore, one of the reasons for food waste is consumers' ignorance of what they have in the refrigerator and when to use it. The conventional method of tracking meals is not very user-friendly because it requires the user to type information into an application or maintain their own written list. Even with camera-equipped refrigerators, there are still blind spots—areas of the refrigerator that cannot be seen—and they are unable to accurately determine a product's age without user input.

Therefore, as refer to recent research, Near Field Communication (NFC) and Radio Frequency Identification (RFID) tags may be useful in addressing this problem. Zuo et al. (2022) claim that RFID makes it possible for systems to quickly identify food items without having to see them, so labels can still be read even if they are hidden behind other things. In a similar vein, Naik et al. (2024) discovered that recently created NFC sensors can be affixed to food packaging in order to wirelessly monitor the food item's freshness history. The Novair system uses RFID and NFC tags to automatically record the moment an ingredient was added and deleted. This eliminates the need for users to manually manage what they have on hand.

## 3. METHODOLOGY

The development of the Novair system followed a structured engineering methodology consisting of four main phases: system design, hardware integration, software development, and performance validation.

First, system requirements were identified based on food spoilage indicators, user needs, and IoT feasibility. Appropriate sensors and modules were selected, including an MQ2 gas sensor for spoilage gas detection, RFID/NFC for ingredient tracking, tic tac buttons for manually clock in and clock out remaining days for the expiration food, and DC fans for air circulation. An Arduino Uno was used for sensor data acquisition and actuator control, while an ESP32 module handled wireless communication.

Next, firmware was developed to process sensor readings, compare values against predefined thresholds, and trigger ventilation, deodorisation, and alert mechanisms. Data was transmitted to the Blynk IoT platform, enabling real-time monitoring, mobile notifications, and remote user control.

System validation was conducted through controlled testing using simulated spoiled food samples to evaluate gas sensor responsiveness, environmental stability, and notification accuracy. Repeated trials were performed to assess reliability, responsiveness, and overall system performance in a refrigerator environment.

## 4. FINDINGS

Evaluation of the Novair prototype focused on its sensing capability, alert responsiveness, ventilation control, and inventory tracking performance. Testing and user interaction activities showed that the system is functional and able to support food freshness monitoring through integrated gas detection, automated responses, and real-time user notifications.

### 4.1 System Performance and Functional Outcomes

The prototype successfully delivered several key operational functions. Real-time alerts were transmitted to the mobile application when increased gas concentration was detected, enabling users to receive immediate notifications regarding potential spoilage. The DC fan control feature was effective in circulating trapped gases within the storage space, while the deodorising mechanism helped minimise unpleasant odours when activated.

The RFID/NFC feature accurately logged ingredient clock-in and clock-out activity, allowing estimation of storage duration. A tic-tac button interface enabled users to manually record the remaining expiry period for selected items, providing flexibility for ingredients without tags. The OLED display presented live gas readings and freshness status, giving users clear visual system feedback during operation.

#### 4.1.2 Sensor Response, Alert Accuracy and User Awareness

Prototype testing indicated that the gas sensor responded consistently to increases in spoilage-related gas levels, triggering timely alerts and activating ventilation to stabilise the readings. Users who interacted with the prototype reported improved awareness of ingredient condition and found the tracking functions useful in preventing overlooked or expired food.

Overall, the combined features including sensing, ventilation, deodorisation, RFID/NFC logging, expiry tracking and mobile notification enhanced the system's practical value for households seeking better hygiene and food waste reduction. These findings demonstrate that Novair is feasible and capable of supporting safer and more organised storage in domestic environments.

## 5. DISCUSSION

The outcomes of the validation process demonstrate that Novair addresses two major household challenges highlighted in the study that were lack of awareness of food conditions during storage and limited monitoring capability in conventional refrigerators. By combining gas-based freshness monitoring with automated actuation and digital alerts, the system supports earlier detection of spoilage and enables users to make more informed decisions about food usage.

The RFID/NFC supported inventory function is particularly impactful, as it reduces reliance on manual entry methods and minimises the likelihood of forgotten or expired items. This complements the sensing system by allowing both physical condition monitoring and record-based tracking of storage duration, creating a more holistic approach to food management.

From an engineering perspective, the findings also indicate that the system architecture which integrates Arduino based data acquisition, ESP32 wireless communication, and mobile-app visualisation is technically feasible and stable within refrigerator-like environments. The coordinated relationship between sensor thresholds and actuator responses strengthens its potential application in real-world domestic settings.

Overall, the discussion supports that Novair has the capacity to contribute toward household food waste reduction, improved freshness visibility, and safer consumption behaviour. Further refinement such as enhanced predictive analytics and broader environmental calibration which may strengthen scalability and long-term deployment potential.



**Figure 1.** NOVAIR : IoT-Based Food Freshness Tracker Prototype.

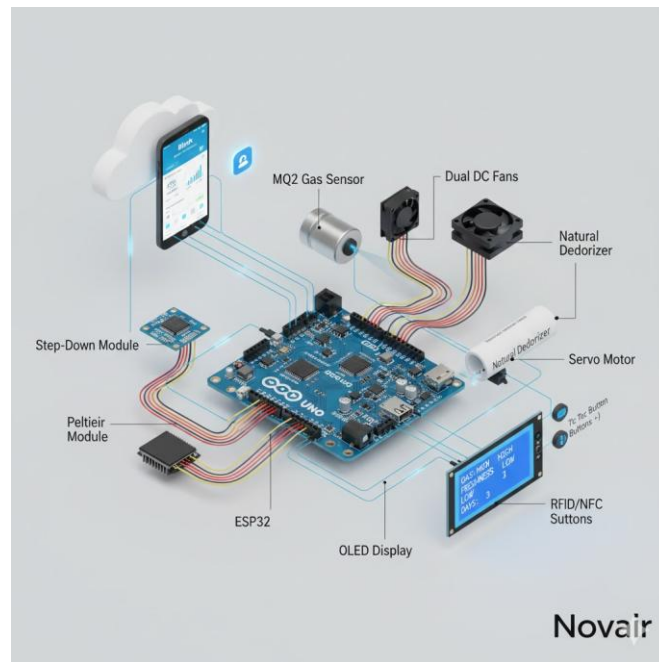


Figure 2. NOVAIR : IoT-Based Food Freshness Tracker Connection.

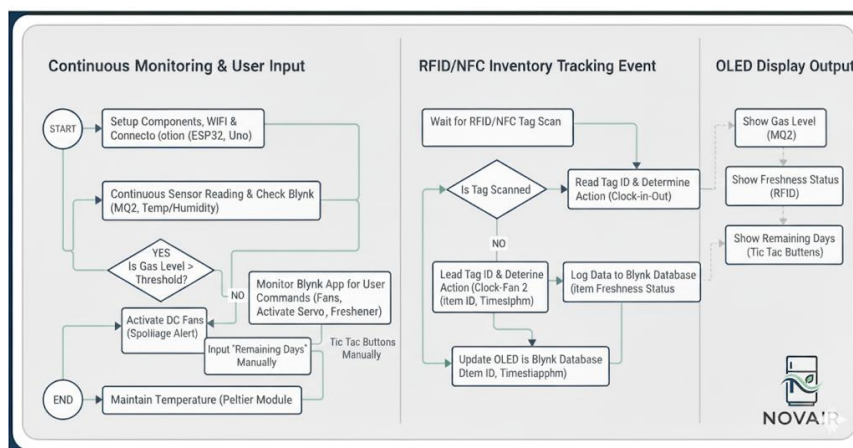


Figure 3. NOVAIR : IoT-Based Food Freshness Tracker Flowchart.

Table 1. Description for NOVAIR .

Functionality	Target Users	Unique Value	Technology Used
Provides real time gas , temperature and humidity monitoring with automated smartphone notifications through Blynk. Includes remote control of DC fans , natural freshener release and RFID / NFC ingredient logging.	Home users, families, working adults, culinary students, small food businesses, and anyone who wants to reduce food waste and improve food hygiene.	Reduces food spoilage risks and improves air quality inside the fridge. Automates monitoring, lowers manual checking effort, and provides early warnings, potentially reducing food waste by up to 35%-50%.	ESP 32, Arduino Uno, MQ2 sensor, OLED display, step down module, tic tac buttons, dual DC fans, Peltier module, RFID/NFC system, Blynk mobile app with cloud-based data storage.

## 6. CONCLUSION

The Novair utilizes IoT control and intelligent sensing technologies to optimize ingredient usage, reduce kitchen waste, and increase food safety. For standard food storage, Novair provides customers with enhanced ability to make informed decisions and monitor their kitchens in real-time through its embedded systems. Future enhancements can include prediction of spoilage using AI technologies; optimization of energy efficiency; enhanced application integrations for more complex smart kitchen environments. In summary, The Novair presents a sophisticated, functional, and expandable solution that improves the process of managing food while paving the way towards the next generation of complex smart fridge systems.

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