International Journal of Scientific Research and Engineering Development-– Volume 7 Issue 6, Nov-Dec 2024

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Smart Fridge Keeper - An IoT-Driven Food Management System

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Abstract:

The Smart Fridge Keeper is a highly advanced, IoT-based system which tries to help in the prevention of food waste in a household through intuitive and efficient management of groceries.

This innovative product has compact, integrated barcode scanner that monitors foods, a cloud database storing product information, and SCANITOR, an application available in mobile devices to give immediate real-time updates and notifications. As users add or remove items from the fridge, the system automatically logs data like product name, quantity, and expiration date, making it easy to manage the inventory. The mobile app lets users track their fridge contents remotely, alerts them when items are near expiration, and keeps them organized. These features help in making informed decisions, which encourage timely consumption of food, less waste, and more sustainable household practices. The Smart Fridge Keeper harmoniously integrates convenience for the user with cutting-edge technology to provide a comprehensive solution in managing food storage and consumption in a way that benefits the household and the environment.

Keywords — **Smart Fridge Keeper, IoT, Barcode Scanning, Cloud Database, Food Waste Management, Inventory Control, Sustainability.**

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I. INTRODUCTION

Food waste is still one of the most significant global problems, with a long-term impact on the environment, economy, and society. The Food and Agriculture Organization (FAO) reports that around 1.3 billion tons of food are wasted every year, which leads to greenhouse gas emissions, economic losses, and social inequalities caused by food insecurity [12][8]. Most of this waste comes from households, where poor inventory management and ignorance of expiration dates are some of the common problems [1][7].

Traditional approaches to household grocery management usually rely on manual tracking of inventories or simple lists, which are prone to errors, inconsistencies, and inefficiencies [3][12]. Such approaches lack the ability to timely alert users to items approaching their expiration dates, thus often causing spoilage. Additionally, the proliferation of perishable products in contemporary homes has made it difficult for users to track and consume items in an efficient manner [1][5].

The Smart Fridge Keeper offers the solution that tackles these challenges as an intelligent, automated offering specifically suited to modern household needs.

This IoT-based system involves scanning barcodes and cloud computing in conjunction with a mobile application for a totally novel approach in the management of groceries. Scanning the barcode logs information about the name, quantity, and expiration date of products in the system. A secure, cloud-based database ensures that this information is accessible in real-time, enabling users to monitor their inventory remotely [3][9]. Notifications powered by Firebase Cloud Messaging alert users about items nearing expiration, fostering better consumption habits and reducing waste [5][12]. By providing a user-friendly interface and leveraging advanced technology, the Smart Fridge Keeper empowers users to manage their food inventory efficiently[10].

II. METHODOLOGY

The methodology of Smart Fridge Keeper is based on the seamless integration of hardware, software, and IoT technologies. The system aims to provide users with an intuitive, efficient, and reliable solution for managing household groceries. Below are the detailed methodologies of the following components:

A. Barcode Scanning for Inventory Management

The system uses the barcode scanner module powered by the barcode_scan2 library to make inventory tracking easier. Users scan the barcodes of grocery items as they put them in the fridge, and details such as product name, quantity, and expiration date are logged [3]. This automation reduces the chance of errors associated with manual entry, ensuring accuracy and saving time.

B. IoT Connectivity for Real-Time Synchronization

The IoT framework of the system will connect the barcode scanner, sensors, and mobile application to the cloud. This will help in real-time data synchronization so that any changes, like adding or removing items from the inventory, are updated instantly across all the connected devices [1][9].

C. Cloud Database for Secure and Scalable Storage

Firestore serves as the system's cloud database, offering a scalable and secure storage solution. The cloud infrastructure not only ensures data security but also allows users to access their inventory remotely, irrespective of their location. This feature is particularly beneficial for users managing multiple households or coordinating with family members [2][9].

D. Mobile Application for User Interaction

The SCANITOR mobile application has a complete interface for inventory management. Its dashboard displays real-time updates, allows users to add or remove items, and offers customization options for notifications. The app's intuitive design ensures that users of all ages and technical proficiencies can easily navigate its features [10] [13].

E. Push Notifications for Timely Alerts

Firebase Cloud Messaging is used to power the system's notification feature, alerting about products that are nearing their expiration dates. Users can set personalized thresholds for receiving notifications based on their preferences, ensuring timely consumption of food items and minimizing waste [5][12].

III. RESULTS

The implementation of the Smart Fridge Keeper has yielded a range of impactful results, showcasing its effectiveness in addressing food waste and improving household inventory management:

A. Performance Evaluation

*1) **Reduction in Household Food Waste :***The system has demonstrated a tangible reduction in food waste among users. Timely notifications about expiring products encouraged households to consume items before spoilage, leading to a significant decrease in waste levels [12] [14].

*2) **Improved Accuracy in Inventory Management :*** The integration of barcode scanning technology eliminated the errors associated with manual tracking. Users reported enhanced accuracy in maintaining their inventory, resulting in better decision-making regarding grocery purchases [3] [9].

*3) **Enhanced User Convenience :*** The SCANITOR mobile application provided users with a centralized platform for managing their inventory. Features like real-time updates, remote access, and customizable alerts simplified the process, making it more convenient and efficient [10] [13].

*4) **Promotion of Sustainable Practices :*** By encouraging users to consume food items before expiration, the system fostered environmentally conscious behaviour. This aligns with global efforts to reduce food waste and its associated carbon footprint [7] [8].

*5) **Economic Savings for Households :*** The reduction in wasted food translated into monetary savings for users. Households reported fewer unnecessary purchases and better utilization of existing groceries [14] [15].

*6) **Improved Meal Planning and Organization :*** Real-time inventory updates enabled users to plan meals more effectively, using ingredients on hand and reducing reliance on last-minute grocery shopping [5] [9].

These results highlight the Smart Fridge Keeper's potential as a transformative tool for household food management, providing both practical and environmental benefits.

B. Feature Demonstrations

*1) **SCANITOR Mobile Application - Dashboard , Products List and Product addition method selector :*** SCANITOR mobile application provides the users with an easy-to-use interface that helps manage food efficiently. The dashboard includes real-time inventory data, the list of products with item details, and a barcode-based or manual product addition system to update the inventory without a hitch.

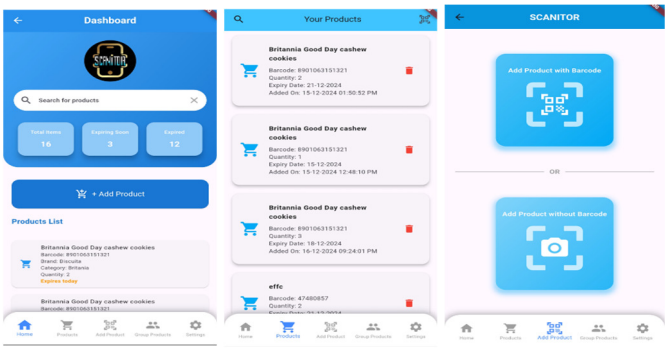

Fig. 1 SCANITOR Mobile Application Dashboard , Products List and Product addition method selector

*2) **Product Addition :** The first screen depicts the usage of SCANITOR's barcode scanning feature to identify the product with its unique barcode. The following screens are about adding products into the application by filling out the details such as category, brand, quantity, and expiry date. All this would be used for inventory tracking for the Smart Fridge Keeper.*

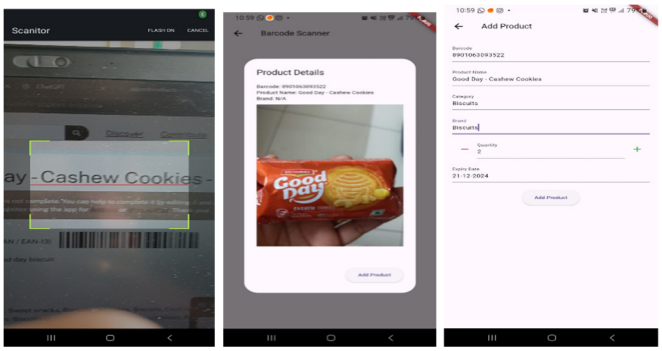

Fig. 2 Product addition

*3) **Notifications :** SCANITOR notifications help users track the fridge inventory by confirming additions of products and giving time-to-time alerts about expiry. This helps households to consume food at the right time to reduce waste and promote sustainable living.*

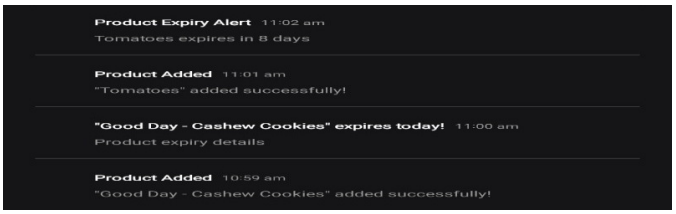

Fig. 3 Notifications

IV. CONCLUSION

Smart Fridge Keeper is one of such innovation that tackles the real-world problem of household food wastage by using automations and technologies. The system transforms traditional inventory management into an efficient process with the help of IoT, cloud computing, and user-centric design. The application features include real-time synchronization, barcode scanning, and timely notifications on the consumption of perishable items before they expire. SCANITOR is an application that is intuitive and user-friendly and empowers its users to manage their groceries with precision and ease. In addition to these practical applications, the system encourages sustainable practices, and reducing food waste and its environmental impact are among the benefits. It is a project that, in addition to meeting household needs, contributes to greater sustainability goals, showing the way technology can be utilized to solve

some of the world's most pressing issues and pave the way for smarter and greener living.

V. FUTURE SCOPE

The Smart Fridge Keeper has such enormous future upgrade potentials that it would even evolve into a wiser, more comprehensive system.

Artificial Intelligence for Better Predictions

The system could use advanced AI algorithms to analyse variables such as temperature, humidity, and user consumption patterns to predict food expiration dates with great accuracy. This would not only improve inventory management but also empower users to make well-informed decisions about food usage, minimizing waste further.

A. Recipe Suggestions

The system could make recommendations of recipes that would use the ingredients in stock, particularly those close to expiration dates. This feature would not only assist the user in using food better but also encourage creativity in meal preparation, offering a convenient way to plan meals while reducing waste.

B. Wearable Device Integration

The expansion of notifications to wearable devices such as smartwatches would ensure that the user receives real-time alerts, regardless of where he is or what device he uses. This seamless integration would enhance user convenience to stay updated on their inventory at all times.

C. Voice-Control Capabilities

The integration of the system with popular voice assistants like Alexa and Google Home would make it possible for users to manage their inventory hands-free. Features such as adding or removing items, checking fridge contents, and receiving updates through voice commands would significantly enhance accessibility and usability.

D. Collaborative Features for Household Coordination

The system could support shared access, allowing multiple household members to view and update the inventory simultaneously and ensure everyone stays informed about fridge contents.

E. Sustainability Metrics

The built-in tracker shall help users view the entire story of the food reduction in detail. Metrics could be the food saved in amount, money saved and the environmental benefit achieved as a result of reduced wastage.

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