A CLOUD BASED SMART PANTRY USING IOT

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Abstract: The abstract of the proposed cloud-based smart pantry utilizing IoT technology encapsulates the development of a system designed to streamline pantry inventory management. Leveraging IoT devices such as microcontrollers and ultrasonic sensors, the system monitors commodity levels in real-time and communicates data to a cloud-based storage platform. Utilizing preset threshold levels, the system generates notifications to alert users when inventory levels are low, ensuring timely restocking. Additionally, the system offers the capability of sharing pantry location for immediate access if required. Through an intuitive user interface accessible via web or mobile, users can efficiently monitor inventory status and manage pantry resources remotely, thereby enhancing convenience and efficiency in daily household or business operations.

Keywords: cloud-based, smart pantry, IoT, inventory management, microcontroller, ultrasonic sensor, real-time monitoring

I. Introduction

The advent of automation and Internet of Things (IoT) technologies has revolutionized various aspects of daily life, offering unprecedented convenience and efficiency. Among these advancements, the concept of a cloud-based smart pantry emerges as a promising solution to address the challenges associated with traditional pantry management. With the proliferation of internet connectivity and mobile devices, individuals seek innovative ways to streamline household tasks, including inventory monitoring and replenishment. The integration of IoT devices and cloud computing in pantry management presents an opportunity to enhance convenience, optimize resource utilization, and minimize the risk of stockouts.

In this context, the proposed cloud-based smart pantry system aims to leverage IoT technology to monitor and manage pantry inventory effectively. By employing microcontrollers and ultrasonic sensors, the system can accurately track the levels of various commodities in real-time. This granular level of monitoring enables users to maintain an up-to-date inventory record without the need for manual intervention. Furthermore, the utilization of cloud-based storage ensures that inventory data is securely stored and accessible from anywhere with an internet connection. This aspect of the system not only facilitates remote monitoring but also enables seamless integration with other smart home or business automation systems. One of the key features of the smart pantry system is its ability to generate timely notifications when commodity levels fall below predefined threshold levels. By setting these thresholds according to individual preferences or consumption patterns, users can proactively manage inventory replenishment, thereby minimizing the risk of stockouts and ensuring continuous availability of essential items. Additionally, the system offers the functionality of location sharing, allowing users to share the pantry's location with authorized individuals for efficient restocking or emergency access. This feature enhances the system's usability and practicality in various domestic or commercial settings. The introduction of a cloud-based smart pantry utilizing IoT technology represents a significant advancement in pantry management systems. By harnessing the power of real-time monitoring, cloud storage, and intelligent notifications, the system empowers users to optimize inventory management, improve resource utilization, and enhance overall efficiency in household or business operations. With its user-friendly interface and seamless integration capabilities, the smart pantry system promises to revolutionize the way individuals manage and interact with their pantry resources in the digital age.

Further sections of this paper will delve into the detailed architecture and operational aspects of the proposed cloud-based smart pantry system. The block diagram of the system will be presented, highlighting the interconnected components and their functionalities. Key components such as IoT devices, microcontrollers, sensors, cloud storage, and notification systems will be discussed in depth, elucidating their roles in the overall system architecture. Additionally, the working algorithm of the system will be outlined, elucidating the step-by-step process by which inventory monitoring, threshold detection, notification generation, and location sharing functions are executed. This comprehensive analysis will provide readers with a thorough understanding of the system's design, implementation, and operational mechanisms, laying the foundation for subsequent sections that explore experimental results, performance evaluations, and potential applications of the proposed smart pantry system.

II. Literature survey

Gaurav V Tawale-Patil's work on "Smart Kitchen Using IoT" (2016) explores the integration of IoT technology into kitchen appliances to enhance convenience and efficiency. The study likely investigates various IoT devices and sensors employed in the kitchen environment, potentially focusing on inventory management, recipe suggestions, and energy optimization. R.A. Ramlee's research on "Smart Home System Using Android Application" (2013) likely discusses the development of a smart home system controlled through an Android application. This work may cover aspects such as home automation, security, and remote monitoring, providing insights into the integration of mobile technology with home automation systems. Yanni Zhai and Xiaodong Cheng's paper on "Design of Smart Home Remote Monitoring System Based on Embedded System" (2015) probably presents a remote monitoring system for smart homes utilizing embedded systems. The study may delve into the hardware and software architecture of the system, emphasizing its scalability, reliability, and energy efficiency. Kaylee Moser, Jesse Harder, and Simon G.M. Koo's work on "Internet of Things in Home" (2014) likely provides an overview of IoT applications in home environments. The study may discuss various IoT devices, protocols, and architectures used to create interconnected smart home ecosystems, focusing on aspects such as energy management, home automation, and user interaction.Yin Jie, Ji Yong Pei, Li Jun, Guo Yun, and Xu Wei's research on "Smart Home System based on IoT Technologies" may explore the implementation of IoT technologies to create intelligent home systems. The study likely discusses the integration of sensors, actuators, and communication protocols to enable automation, energy efficiency, and remote monitoring in smart homes. Narayan Sharma, Nirman Singh, and Tanmoy Dutta's work on "Smart Bin Implementation for Smart Cities" (2015) likely investigates the deployment of smart waste management systems in urban environments. The study may focus on sensor-based waste monitoring, optimization of waste collection routes, and integration with city-wide IoT networks.

The literature survey provides a comprehensive overview of existing research on IoT applications in smart homes and related domains. Various studies have explored the integration of IoT devices, sensors, and communication technologies to create intelligent home systems capable of automation, remote monitoring, and energy optimization. While some works focus on specific applications such as smart kitchens or waste management, others address broader topics such as home automation, energy prediction, and appliance control. Overall, these studies highlight the potential of IoT technologies to transform traditional homes into interconnected, efficient, and user-friendly environments. The proposed cloud-based smart pantry utilizing IoT technology builds upon this body of research, offering a novel solution for efficient pantry inventory management and resource optimization in domestic and commercial settings.

III. Existing system:

The existing system for managing a pantry typically relies on manual inventory checks, which can be time-consuming and prone to errors. Users often need to physically inspect items in the pantry to determine what needs to be restocked, leading to inefficiencies and potential waste. Additionally, there may be limited visibility into pantry inventory levels, making it difficult to anticipate when items need to be replenished. Overall, the existing system lacks real-time monitoring and automation capabilities.

IV. Proposed system with block diagram

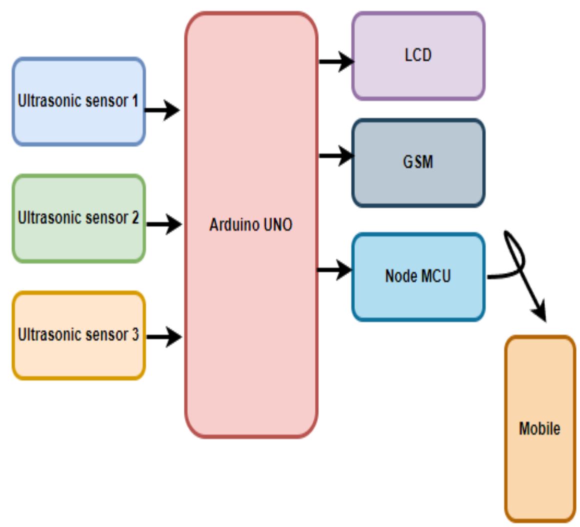

Fig 1: Block diagram of the proposed system

The proposed smart pantry system leverages a combination of hardware components, including an Arduino Uno microcontroller, a NodeMCU WiFi module, an ultrasonic sensor, an LCD display, and a GSM module, to revolutionize pantry management. The Arduino Uno serves as the central processing unit, responsible for data aggregation, analysis, and control. It interfaces with the NodeMCU WiFi module to establish connectivity with the cloud-based server, enabling remote access and monitoring of pantry inventory. The ultrasonic sensor is deployed to accurately measure commodity levels in real-time, providing crucial data for inventory tracking. The LCD display offers a user-friendly interface for local monitoring and interaction with the system, displaying real-time inventory information and status updates. Additionally, the GSM module facilitates communication with users by sending notifications via SMS in areas with limited or no internet connectivity. Together, these components form a robust and efficient smart pantry system that enhances convenience, minimizes stockouts, and optimizes resource utilization for both domestic and commercial applications.

V. Components Used and its Description

ESP8266 Node Mcu: The ESP8266 is a popular and inexpensive Wi-Fi module commonly used in Internet of Things (IoT) projects. It features a built-in microcontroller and Wi-Fi capability, allowing it to connect to the internet and communicate with other devices. The ESP8266 can be programmed using various programming languages and development environments, making it versatile for a wide range of applications.

Fig 2: Node MCU

Ultrasonic sensor: An ultrasonic sensor is a device that emits high-frequency sound waves beyond the range of human hearing and detects their reflections to measure distance or detect objects. It typically consists of a transmitter and a receiver. The transmitter emits ultrasonic pulses, which travel through the air and bounce off objects in their path. The receiver then detects the returning echoes and measures the time it takes for the sound waves to return. By calculating the time difference between emission and reception, the sensor can determine the distance to the object.

Fig 3: Ultrasonic sensor

LCD (Liquid Crystal Display): The LCD serves as the primary interface for users to interact with the cloud-based smart pantry system. It displays important information such as current inventory levels, alerts for low-stock items. The LCD screen provides clear and concise visual feedback, allowing users to quickly assess pantry status at a glance.

Fig 4: LCD Display

Arduino uno: The Arduino microcontroller serves as the brain of our cloud-based smart pantry system, orchestrating the interaction between various hardware components and facilitating communication with the cloud server. Based on an open-source hardware platform, Arduino offers flexibility and ease of programming, making it ideal for prototyping and building IoT solutions. Equipped with multiple digital and analog input/output pins, the Arduino enables connectivity with sensors, actuators, and other peripheral devices crucial for pantry inventory management. Its low-power consumption and compact size make it suitable for deployment in constrained environments.

Fig 5: Arduino Uno

GSM (Global System for Mobile Communications): The GSM (Global System for Mobile Communications) module is a crucial component in many IoT projects, including our cloud-based smart pantry system. Essentially, it serves as a communication interface between the smart pantry and external networks via cellular networks. The module enables the smart pantry system to send notifications, alerts, or status updates to users or administrators via SMS (Short Message Service) or GPRS (General Packet Radio Service). Additionally, it facilitates remote monitoring and control of the pantry system, allowing users to access real-time data or trigger actions from their mobile devices

Fig 6: GSM Module

VI. Working principle

Working algorithm for the proposed smart pantry system is as follows:

Initialization: Initialize all necessary components, including the Arduino Uno, NodeMCU, ultrasonic sensor, LCD, and GSM module. Set up communication protocols between the Arduino Uno and other components.

Read Sensor Data: Continuously read data from the ultrasonic sensor to determine the distance to the top surface of the commodities in the pantry shelves. This distance corresponds to the remaining quantity of each item.

Data Processing: Process the raw data obtained from the ultrasonic sensor to calculate the quantity of each item in the pantry. This involves converting the distance measurements into usable units (e.g., volume or weight) based on calibration parameters.

Update LCD Display: Display real-time inventory information on the LCD screen connected to the Arduino Uno. This allows users to monitor inventory levels directly from the pantry.

Check Threshold Levels: Compare the calculated quantity of each item against predefined threshold levels. If the quantity falls below the threshold for any item, proceed to the next step.

Send Notification: If the quantity of any item falls below the threshold, trigger the GSM module to send a notification to the user's mobile device via SMS. The notification should include details of the item and its current quantity.

Communication with NodeMCU: Establish communication between the Arduino Uno and the NodeMCU WiFi module. Prepare the data for transmission to the cloud-based server for further analysis.

Send Data to Cloud Server: Send the processed inventory data to the cloud-based server using the NodeMCU WiFi module. Ensure secure transmission and proper authentication to access the server.

VII. Results

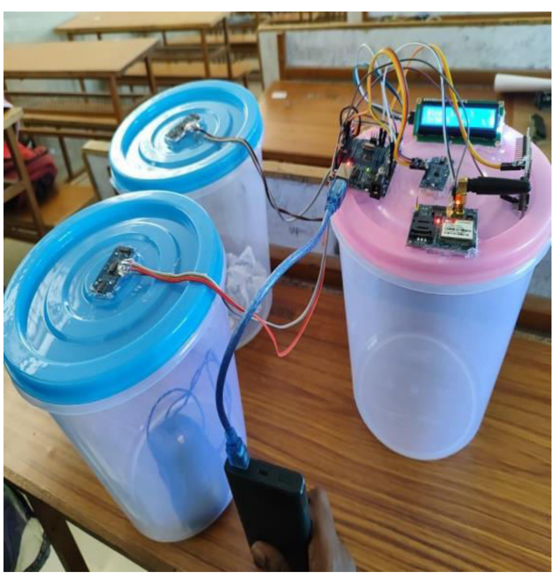

Fig 7: Developed hardware prototype

The figure displays the physical prototype of the smart pantry system, showcasing the integration of various components such as the Arduino Uno, NodeMCU, ultrasonic sensor, LCD display, and GSM module. The prototype demonstrates the practical implementation of the proposed system in a real-world setting, highlighting its compact design and functionality.

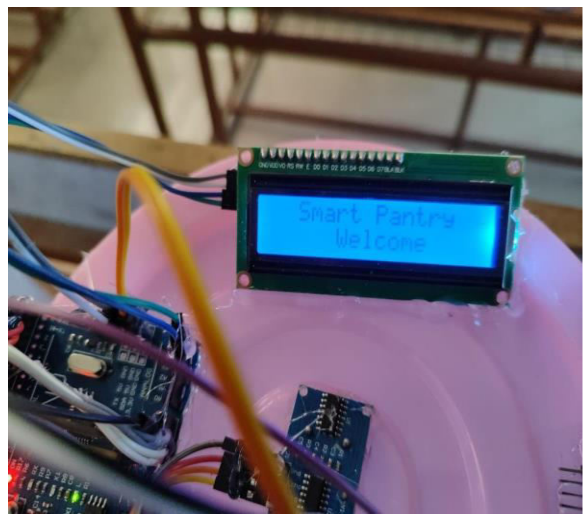

Fig 8: LCD display showing initialization message

The LCD display exhibits an initialization message upon system startup, indicating that the smart pantry system is booting up and initializing its components. This message provides users with visual feedback that the system is powering on and preparing for operation, ensuring a smooth user experience.

Fig 9: LCD display showing remaining groceries message

The LCD display illustrates the real-time monitoring of pantry inventory by presenting the percentage of remaining groceries for each item. This visual representation enables users to quickly assess the status of their pantry stocks at a glance, facilitating informed decision-making regarding inventory management and restocking.

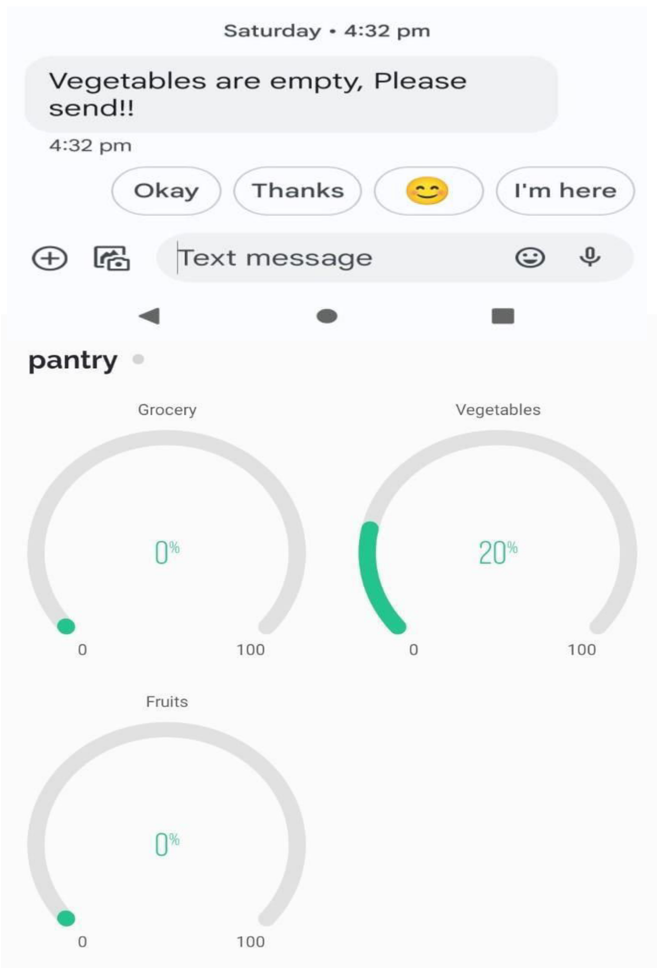

Fig 10: Real time graphical interface

In the figure, users can observe a graphical representation or a list of items along with their current quantities. Green indicates that the inventory level is within the acceptable range, while red signifies that the inventory level has fallen below the predefined threshold. Users can interact with the interface to adjust threshold levels, view detailed information about specific items, and access historical data for analysis purposes. Overall, the real-time monitoring interface offers a user-friendly and intuitive way to monitor and manage pantry inventory effectively.

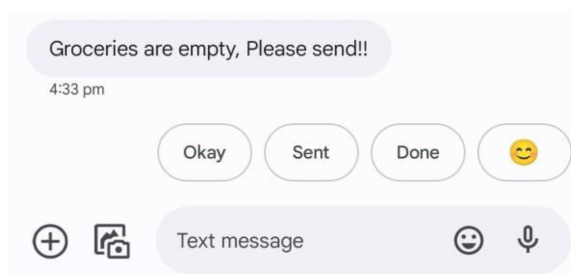

Fig 11: SMS Message received to mobile

The figure depicts messages received by the user's mobile device via the GSM module, notifying them of low stock levels or other relevant alerts. These messages provide timely notifications to users, enabling them to take immediate action to replenish depleted items or adjust inventory settings as necessary, thereby ensuring continuous availability of essential commodities.

Conclusion:

The development and implementation of the smart pantry system represent a significant advancement in pantry management technology. Through the integration of IoT devices, cloud-based infrastructure, and real-time monitoring capabilities, the system offers users a convenient and efficient solution for tracking and managing pantry inventory. The system's ability to accurately measure commodity levels, set threshold alerts, and provide real-time notifications ensures that users can effectively monitor and replenish pantry stocks in a timely manner, thereby minimizing the risk of stockouts and optimizing resource utilization. Additionally, the user-friendly interface and remote access capabilities enhance user convenience and accessibility, allowing for seamless pantry management from anywhere, at any time. Overall, the smart pantry system holds great potential for revolutionizing household and commercial pantry management practices, offering improved efficiency, convenience, and peace of mind to users.

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