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Smart Pantry System

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Abstract*: An innovative system that makes use of the newest technologies to improve kitchen pantry management is known as a "Smart Pantry system." To track the foods kept in the pantry and keep an eye on their expiration dates, the system uses sensors, cameras, and machine learning algorithms. Users may avoid food waste, save time, and make wise grocery shopping choices with the aid of this system. The Smart Pantry system is made up of a number of parts, such as sensors and cameras that aid in the detection of pantry contents. To keep track of inventory levels, these components can be mounted on pantry shelves or inserted in pantry drawers. To identify the products kept in the pantry, the system employs machine learning algorithms to analyse the data gathered by these sensors and cameras. The Smart Pantry system is capable of learning and adapting to users' tastes and behaviours over time by utilising artificial intelligence and machine learning techniques. The capability to monitor the expiration dates of the foods kept in the pantry is one of the Smart Pantry system's primary advantages. The device can track a product's shelf life and notify users when it is about to expire by using sensors and cameras. By doing so, people can prevent food waste and enjoy the products before they spoil. Additionally, the system can offer recipe recommendations based on the ingredients in the pantry, helping to further reduce food waste and promote sustainable living. The ability to generate and manage shopping lists is yet another crucial component of the Smart Pantry system. The system will automatically update inventory levels and alert users when an item is running short. Users can add products to their shopping list through the mobile app or web portal. Users may keep informed and organised while also doing away with manual inventory management.

***Keywords*: sensors, cameras, machine learning algorithms.**

1. Introduction

As a response to the difficulties of managing kitchen pantries, the idea of a Smart Pantry system is quickly gaining appeal. Keeping track of pantry inventory can be challenging due to the fast-paced nature of modern life. As billions of tonnes of food are wasted each year, this problem is also becoming more and more urgent. The Smart Pantry system is a technology advancement that makes use of sensors, cameras, and machine learning algorithms to make managing the pantry easier, cut down on food waste, and encourage sustainable living.

To track and manage pantry inventory, the Smart Pantry system consists of a number of parts that work together. Sensors, cameras, and machine learning algorithms are some of these parts. The sensors are put in the pantry drawers or mounted on the shelves to detect the presence of objects. The sensors and cameras collect data, which is then analysed by machine learning algorithms to identify the things kept in the pantry. The Smart Pantry system may gradually learn and adjust to the preferences and behaviours of the consumers by utilising artificial intelligence and machine learning techniques. Monitoring the expiration dates of the foods kept in the pantry is one of the system's primary features. The system can track a product's shelf life and notify consumers when it is about to expire by using sensors and cameras. Users who use this feature consume food before it spoils and reduce food waste. In order to promote sustainable living and minimize food waste, the system can also recommend meals based on the ingredients found in the pantry.

2. Objectives

The smart pantry system was created to give pantry inventory management that is quick, easy, and economical while also reducing food waste. The system's goals and objectives centre on giving users the information and resources they need to manage their pantry inventory wisely and cut down on food waste.

1. Efficient inventory management:
2. Reduce food waste.
3. Timesaving
4. Convenient:
5. Real-time inventory tracking
6. Automated alerts
7. Recipe suggestions
8. Smart shopping
9. Personalization

By gradually understanding its users' tastes and behaviours, the Smart Pantry system promises to personalise the user experience. It offers a personalised pantry inventory management solution because the system can make recipe and purchasing suggestions based on the preferences and shopping patterns of specific users. The Smart Pantry system seeks to offer users a quick, easy, and customized way to manage their pantry inventory, cut down on food wastage, and save time. money. The system's goals are to give consumers real-time information, automated warnings, recipe ideas, smart shopping suggestions, customization to suit their particular requirements and tastes, and other such services.

3. Literature Review

In this section, research is conducted before beginning the

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project in order to understand the various approaches that have been employed in the past. The systems that are now in place underwent a thorough study. The advantages and disadvantages of the current systems were helped to be determined by this study.

Controlling inventory plays a key role in efficient kitchen management. Monitoring the kitchen management enables better informed planning and decision-making. People now prefer to monitor and execute their everyday activities using the smart devices they carry everywhere rather than physically recording and monitoring things because technology has advanced significantly and everything around us is becoming automated. One of the biggest issues in many industries is how to maintain and record the tracing of everyday common inventory [1].

The system also places an immediate order if the product weight falls below a predetermined threshold. The project employs cameras rather than sensors to read the data inside the cabinet and Google Firebase for the web application. The system is lacking in desirable features like cabinet weight and temperature display, and it also does not track previously placed orders [2]. The idea of a "Smart Pantry" would enable the typical customer to manage inventory and use automation to fetch things from a pantry. Currently, some smart refrigerators are available on the market that can monitor inventory using pictures that can be sent to a smartphone. For easier access to food, some smart pantries incorporate shelves that are motorized.

However, no system is able to simultaneously monitor waste management practices, identify the household-level drivers and barriers to the production of food waste, and offer a more effective means of preventing food waste through the wise and sufficient use of ingredients [3]. The characteristics and fundamental applications of RFID technology are introduced in this paper. The data flow of the intelligent inventory system is then examined from the perspectives of business and function. Following this, the paper proposes specific framework programmes and function modules of the intelligent inventory management system based on IoT RFID technology, with a focus on elaborating the design and implementation process of the intelligent inventory system [4]. The implementation of a smart supermarket management system using IoT has been covered in this essay. The created system efficiently monitors the condition of the grocery goods and notifies the user via a mobile application if the number of the grocery items falls below the minimal quantity that was established [5]. This article covers the structure and concepts of a novel form of intelligent Inventory Management System based on the IoT [6]. We offer an effective approach in this work for managing inventories across a range of applications involving solid or liquid assets. Inventory management is made more effective by using IOT-based solutions, which automate tasks that would otherwise need extra labour between the measurement and order placement phases [7]. By creating unique product types, products, and product groups, you can efficiently inventory all of your hardware and software assets. Keep tabs on the financials for the important assets, particularly the details of their depreciation. Create personalised reports on your inventory of IT assets for efficient planning and budgeting [8]. An inventory prediction model was also put out in this study. The best inventory prediction accuracy using this proposed prediction model might be as high as 66.3%. The food processing and distribution sector can efficiently and accurately manage inventories by using sequential patterns based on professional opinions [9]. In order to increase resource efficiency, this study provides a thorough analysis of IoT and big data-based food waste management models, algorithms, and technologies. It also identifies the principal issues and future research opportunities [10].

4. Methodology

The Smart Pantry system was developed using a technique that includes several important steps, such as determining user needs, building the system architecture, creating the software and hardware components, testing and fine-tuning the system, and releasing it to end users.

A. Determining User Needs

The market research and user surveys conducted as part of the Smart Pantry system development are used to determine user needs. In order to do this, it is necessary to compile data about the pantry inventory management needs and concerns of users, as well as the features they would like to see in the system.

B. Designing the System Architecture

The next stage is to design the system architecture based on the user needs that were discovered in the first step. This entails determining the hardware and software parts of the system that are required, such as the sensors, cameras, microcontrollers, and cloud-based servers. The architecture ought to be created with scalability and ease of maintenance in mind, as well as the user needs stated in the first step.

C. Creating Hardware and Software Components:

The Smart Pantry system's hardware and software components need to be created next. This include creating and coding the firmware for microcontrollers, sensor and camera interfaces, machine learning algorithms, and user interfaces. A seamless interaction between the hardware and software components will give users a simple and effective experience.

D. Testing and System Refinement

Following the development of the hardware and software components, the system must be tested and improved. In order to do this, user testing must be carried out in order to get input on how well the system is working, to find bugs and other problems, and to make the necessary system modifications. This stage is essential to ensuring that the Smart Pantry system satisfies user needs and offers a productive and trustworthy method of managing pantry inventory.

E. Deployment

The final step is to deploy the Smart Pantry system to end-users. This involves rolling out the system to a small group of

beta testers, gathering feedback on its performance, and making any final adjustments before releasing it to the public. The system should be easy to install and use, with clear instructions provided to users to ensure a smooth deployment. The Smart Pantry system is designed to help users manage their pantry inventory efficiently and effectively. The system operates using a combination of hardware and software components, including sensors, cameras, microcontrollers, and cloud-based servers.

5. Proposed Model

A modern technology-based solution called a "smart pantry system" is intended to simplify and streamline the administration of food in a home or workplace. To provide an automated and intelligent approach to food management, it typically comprises of a combination of hardware and software components. A smart fridge, pantry shelves, and storage bins are frequently seen among the hardware elements of a smart pantry system. These have sensors and are Bluetooth or Wi-Fi enabled and connected to the internet. When food items are added or removed, the sensors can identify them, and the system can instantly update inventory records. A mobile or web-based app that enables users to remotely monitor and control their pantry inventory often makes up the software component of a smart pantry system. The software might have capabilities like barcode scanning to easily add items to the inventory, warnings when supplies are running short, and the capacity to make shopping lists based on available inventory levels. In order to analyse inventory data and provide recommendations based on user preferences and consumption trends, the smart pantry system uses artificial intelligence and machine learning algorithms. For instance, the system can advise a user to buy more of a particular food item if it notices that they usually consume that type of item. In conclusion, a smart pantry system provides a practical and effective solution to handle pantry inventory, cut down on food waste, and streamline grocery shopping. You can sense physical pressure, squeezing, and weight using load cells, which are sensors. Anywhere between 100g and 10kg of applied force can be detected by this sensor. It takes three force-sensitive resistors to accurately weigh each ingredient. by positioning the load cell in the middle of each compartment, underneath. By drilling two holes for each sensor, you can remove the sensor's pin from the packaging. After that, to link the sensors to the Node MCU ESP32, add jumper wire to each sensor pin. Place the base box on top of the three inside boxes. When a force is applied, a load cell changes its value. Hard surface pressure is bad for the load cell, and you won't receive an accurate reading. In order to improve productivity, we double-sided taped a little piece of foam to the bottom of each inner box. Put it in a location where it will precisely touch the sensor. Due to the analogue nature of the Load Cell's output, a Node MCU ESP32 analogue pi is needed to read the value from the sensors. Based on the sensor reading, it determines weight in grammes. Any useful remote access must be installed on a server. We will upload all values to Blynk Cloud for this reason. Data uploading to the cloud was accomplished using the Node MCU ESP32. Using the serial port, Arduino transmits data to the Raspberry Pi. The data is subsequently uploaded to Blynk cloud by Raspberry Pi utilising the WebSocket protocol. Values are displayed in Blynk app, even the temperature and humidity of the environment is also displayed.

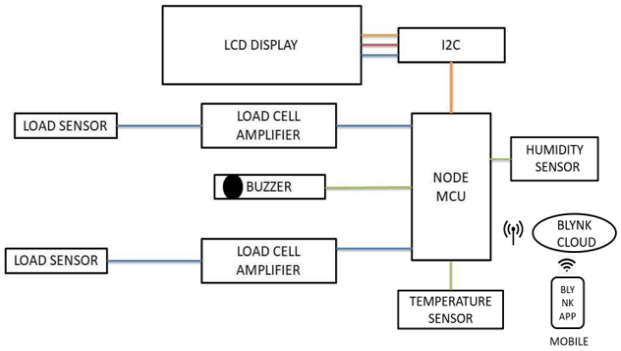

Fig. 1. Block diagram

6. 6.Components Required

A. Software Components

1) Blynk App

The Internet of Things (IoT) devices can be used with mobile apps made with the help of the well-known mobile app development platform Blynk. Blynk offers a user-friendly drag-and-drop interface that makes it simple and quick for developers to create unique mobile applications for managing and controlling their IoT devices. Blynk is a flexible option for IoT developers because it supports many different hardware platforms, such as Arduino, Raspberry Pi, ESP8266, and others. Additionally, Blynk offers a library of pre-built widgets, such as buttons, sliders, gauges, and graphs, so that programmers can design interactive user interfaces for mobile applications.

2) Arduino IDE

Software is used to create and upload code to Arduino boards, and it is called the Arduino Integrated Development Environment (IDE). For use with Windows, Mac OS X, and Linux, this cross-platform application is available. Because of its ease of use and straightforward design, the Arduino IDE is suitable for beginners with little to no programming background. It has a code editor with syntax highlighting and autocomplete to make writing code simpler. It also has a serial monitor for testing and debugging. The integrated development environment (IDE) is pre-loaded with a number of libraries and examples that may be used to create a variety of applications, such as robotics, automation, and home automation.

B. Hardware components

1) NodeMCU-32

ESP32-WROOM-32 is the foundation for the development board known as NodeMCU-32. A common microcontroller used in Internet of Things projects is the ESP32, which supports Wi-Fi and Bluetooth.

The NodeMCU-32 board's salient characteristics include:

- Wi-Fi 802.11 b/g/n/e/i compatibility with rates up to 150Mbps.
- Dual-core 32-bit CPU operating at up to 240MHz.
- Bluetooth 4.2 BLE compatibility.

- Micro USB port for power and programming.
- GPIO pins.
- 512KB SRAM and 4MB flash memory.
- Support for SPI, I2C, I2S, UART, ADC, DAC, and PWM.

Fig. 2. NodeMCU-32

2) Load Cell Sensor

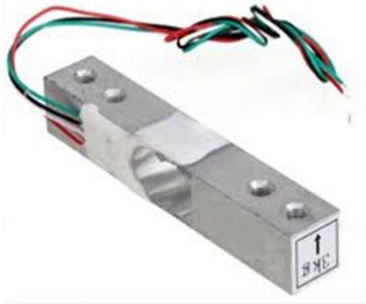

Fig. 3. Load cell sensor

A transducer that transforms force or weight into an electrical signal is a load cell. Load cells are frequently employed in commercial and industrial settings where it is necessary to measure the weight of an object, such as in weighing scales, industrial automation, and material testing. The primary idea behind a load cell is that it deforms slightly when a force is applied to it. The load cell's electrical resistance is altered by the deformation, and this electrical resistance can be measured and transformed into an output signal that is proportionate to the applied force. Utilising the output signal, the weight can then be shown on a digital display or other devices can be controller.

3) HX711 module

Fig. 4. HX711 module

For use in weighing scales and industrial control applications, the HX711 is a precision 24-bit analog-to-digital converter (ADC) with an inbuilt amplifier. The module is frequently used in pressure sensors and load cells to measure changes in weight or pressure. Two analogue input channels on the HX711 module can be set up as single-ended or differential inputs.

The HX711 module's salient characteristics include:

- 2.6V to 5.5V input voltage
- 2 differential or 4 single-ended input channels
- 10-80 samples per second (SPS) for output data
- 128 or 64 programmable gains
- Internal oscillator
- Power-on reset on the chip

4) Temperature and Humidity Sensor

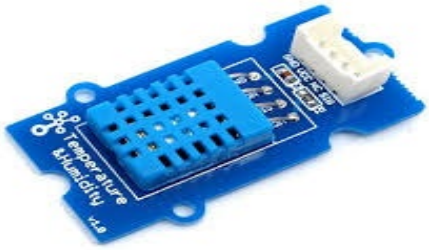

Fig. 5. Temperature and humidity sensor

A digital sensor module called the Grove Temperature and Humidity Sensor gives precise temperature and humidity readings in a variety of situations. The module is compatible with the Grove system and based on the DHT11 sensor, enabling quick and uniform connections with other Grove modules.

The Grove Temperature and Humidity Sensor has a number of important features, including:

- 0°C to 50°C in the temperature range.
- 20% to 90% relative humidity
- Supply voltage: 3.3V to 5V
- Digital output: single-wire communication protocol
- Accuracy: 2°C temperature, 5% RH humidity.

5) Buzzer

Fig. 6. Buzzer

A buzzer is a piece of electronic equipment that emits a loud tone or sound. Several gadgets, such as alarm clocks, timers, video game consoles, and musical instruments, use buzzers. A vibrating diaphragm or a piezoelectric element, along with an electromagnetic coil, make up a buzzer. The coil generates a magnetic field that attracts the piezoelectric element or

diaphragm to it when a voltage is given to it. The piezoelectric element or diaphragm vibrates as a result of this movement, creating a sound that can be heard. From tiny, low-powered buzzers used in electrical gadgets to bigger, high-powered buzzers used in industrial applications, buzzers come in a variety of sizes and configurations.

7. Results

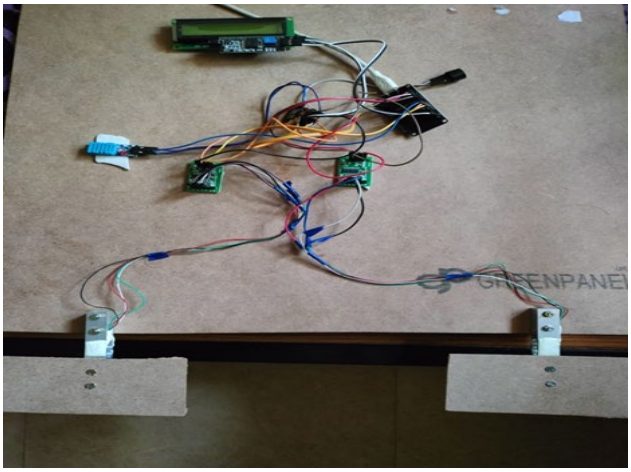

Fig. 7. Smart pantry system

Fig. 8. Working of smart pantry system

Fig. 9. Blynk App

Fig. 10. Weight display

Fig. 11. Dashboard

8. Conclusion and Future scope

The smart pantry system is an innovative innovation that has the ability to completely change how we manage pantry inventories in both home and business settings. Numerous advantages of the system include better inventory control, less waste, and user-friendly design. The Smart Pantry system enables customers to watch inventory levels in real time and receive notifications when things are running low through the use of sensors and other cutting-edge technologies. This not only helps to decrease waste by eliminating overstocking, but it also guarantees that users always have the components they need on hand to cook meals or snacks.

The Smart Pantry system has further advantages and possible uses in a variety of environments, including residential residences, commercial kitchens, and food manufacturing

facilities. The system can assist businesses lower expenses, boost efficiency, and boost overall production by offering sophisticated inventory tracking and management features.

The Smart Pantry system does, however, have some possible drawbacks and restrictions. One factor that some users may find difficult to accept is the system's high hardware and software investment requirements. Concerns about security and privacy are also raised, particularly in relation to the gathering and utilisation of information regarding pantry inventory.

Despite these difficulties, the Smart Pantry system is a fascinating technological advancement with enormous potential for further development and use. The system has the potential to grow more robust and adaptable as technology progresses, offering useful inventory management skills in a variety of contexts.

In terms of pantry inventory management, the Smart Pantry system is a considerable advancement. The system has the ability to boost productivity, cut down on waste, and give consumers more convenience by utilising cutting-edge technologies like sensors, artificial intelligence, and data analytics. As a result, in the years to come it is expected to become a tool that is used for controlling pantry inventory that will be used more and more.

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