Cybernetic Proportional Dispenser System

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ABSTRACT

The Automatic Grocery Dispenser is an advanced system designed to add precision and control to the dispensing of granular grocery items. The system contains a servo motor that adjusts its position to modulate the flow of groceries within a fixed cap containing a strategically placed outlet. In its default position, the servo motor blocks the outlet, thus no flow occurs. When activated, the motor shifts the part to an open position where there is controlled discharging of groceries.

A load cell is used to measure weight in real-time to ensure that the volume dispensed is accurate and exactly reflects the user's input. This mechanism eliminates errors, increases efficiency, and reduces waste. The assembling of mechanical precision with electronic control systems makes the dispenser an advanced tool for the handling of modern grocery. Its architecture designed to focus on security and scalability makes it a better way to be used in residential, commercial, or industrial settings where accuracy and automation are required.

Keywords: Servo Motor, Load cell, Arduino, Dispenser system, Keypad, i2cLCD, Automatic, precision, hygiene.

INTRODUCTION

The grocery sector is facing several significant challenges that hinder efficiency and hygiene in the handling and distribution of products. One of the primary issues is the inconsistency in measurement during manual dispensing, as human error often leads to inaccurate weighing of grocery items. This discrepancy results in over-dispensing, under-dispensing, or spillage, causing unnecessary wastage and reducing overall efficiency. However, the issue that is even more critical is hygiene within the handling process. Grocery manual handling increases the risk of contamination, and shared or bulk environments are critical. Unhygienic conditions or physical contact with groceries lead to the spreading of bacteria or other contaminants, affecting safety and quality in products. This is very important in food distribution where hygiene and prevention of contamination are essential for consumer health and satisfaction.

In addition to these issues, the traditional forms of grocery handling are operationally inelastic and create time delays and bottlenecks, particularly in such high-demand places as supermarkets or distribution centers. Additionally, their lack of automaticity complicates managing resources because inventory and stock levels become even harder to keep track of without automated systems. In effect, improper alignment between supply and demand leads to a rise in operational costs and may lead to lower profitability.

Lastly, this inability to decrease waste and contamination leads to sustainability challenges, with excessive food waste and poor handling practices contributing to environmental harm. These issues illustrate the

need for automation and precision in the grocery sector, and solutions such as the Automatic Grocery Dispenser may provide a more efficient, hygienic, and sustainable alternative for traditional methods.

Automation has become the backbone of modern innovation, changing industries and redefining daily life. In this context, the Automatic Grocery Dispenser emerges as a pivotal solution for enhancing precision, convenience, and efficiency in grocery management. Designed to cater to the needs of households, supermarkets, and bulk distribution centers , this system seamlessly integrates mechanical and electronic components to provide a secure, automated dispensing mechanism for granular grocery items such as grains, pulses, and other small commodities.

The salt and pepper area - the innovative control system made by the utilization of a servo-actuated control mechanism - works by regulating the flow of groceries through a stationary cap with a strategically positioned outlet. Initially, in its travel position, the servo motor covers the outlet, effectively blocking it and preventing any incidental flow. Upon activation, the motor transitions into an open position and then allows accurate passage of products by the contents through the cap. This mechanical ingenuity makes sure that the flow is controlled and also matched to the requirements of the user.

The accuracy of the system is achieved with the help of a load cell that is included in the system. It measures the weight of the groceries at real time so that the precise amount of groceries requested by the user is dispensed. The system thus minimizes wastage and enhances its efficiency. Moreover, the device features a secure user authentication mechanism wherein the password entered via a keypad will ensure that only authorized users are allowed to access the dispensing function . If the user fails to enter the correct password, the system will protect itself by displaying an error message on an LCD screen and prompting the user to re-enter the credentials.

The Automatic Grocery Dispenser holds a design philosophy mainly aimed at functionality, security, and adaptability. Its user-friendly interface creates robust user-friendliness in its component parts, making it a versatile solution for various applications. This system, that automates the traditionally manual task of stocking shelves, is consistent with the increasingly smart technologies used globally in order to manage sustainability, resource, and convenience in daily operations.

This paper explores the underlying principles, mechanisms, and applications of the Automatic Grocery Dispenser, demonstrating its potential to revolutionize grocery management and its implications for the future of automated systems in both residential and commercial settings.

PROBLEM STATEMENT

Grocery sector is one in which huge challenges arise in ensuring the accuracy, efficiency, and hygiene of dispensing and handling in bulk environments. Traditional manual methods tend to result in inconsistent measurements and wastage because of over-dispensing or spillage. Handling groceries manually within shared or bulk settings heightens contamination risks and brings serious concerns related to hygiene and product safety into the picture. This not only compromises the quality of the products but also affects consumer trust. Moreover, labor-intensive processes create operational inefficiencies, which delay operations and increase costs, besides making it hard to maintain inventory management accurately. In view of the growing demand of the sector and increasing sustainability requirements, the urgency to develop an automated solution for these challenges with precise measurement, hygienic handling, and overall operation efficiency is ever more pressing.

SOLUTION

The Automatic Grocery Dispenser is an advanced solution to the issues of inaccuracy, wastage, contamination, and inefficiency in the grocery sector through the incorporation of automation, precision, hygiene, and user authentication. Even though it does not actively track the quantity of groceries present in the hopper, the system addresses these key concerns through its innovative features:

1. Precision and Accuracy in Dispensing

The heart of the Automatic Grocery Dispenser is its integration of a servo motor and a load cell. The servo motor moves the outlet cover to control the flow of groceries, and the load cell continuously measures the weight of the dispensed groceries. This system ensures that the exact amount of groceries requested by the user is dispensed, thus eliminating human error and the problems of over- or under-dispensing. The accuracy of the system prevents wastage by dispensing groceries only when the correct weight is reached.

2. Hygiene and Contamination Prevention

The Automatic Grocery Dispenser minimizes the risk of contamination, a significant issue in the traditional manual dispensing process. This minimizes the entry of germs or contaminants since the human hand only touches the system minimally. The hopper cap is rigid and will not allow the groceries to touch any outer surfaces until the servo motor is moved to let them pass through the provided outlet. This way, the system enhances the hygiene and safety of the products by reducing the amount of physical handling and exposure to unsanitary conditions.

3. Operations and Automation Efficiency

The dispenser completely automates the dispensing process. This means there is no need for human interaction in the process, and therefore, the time taken to dispense is greatly reduced. This increases operational efficiency, especially in high-demand environments such as supermarkets and distribution centers. The servo motor moves the cap to release the groceries at the precise moment needed, and therefore, the dispensing will be faster and more consistent without errors. This reduces labor costs, bottlenecks, and inefficiencies that are common in manual systems.

4. Dispensing on Basis of Weight Not With Inventory Count

The system does not have the functionality to show the current quantity in the hopper but still calculates the weight of groceries being dispensed in real time based on the load cell. When weight is entered by the user, the system dispenses groceries until it reaches a set weight. In regard to this point, though it does not track the leftover groceries entirely, this weight-based dispensing system is highly efficient in controlling portions of grocery items accurately through every transaction for real-time multi-grocery management.

5. Security and Access Control

The system also contains user authentication to ensure that only authorized users can use the dispenser. The user can enter a password before dispensing through a keypad, and in case the password is incorrect, the system will display an error on the LCD screen and will ask for re-entry. This feature will ensure that the dispenser remains secure and that unauthorized usage is prevented, especially in shared environments where multiple people may interact with the system.

6. Sustainability

The system eliminates over- or under-dispensing, which means it minimizes the total amount of food wasted during the dispensing process. Over- or under-dispensing is eliminated through the dispenser. In addition, the system minimizes the impact of contamination and physical handling on the environment. It is consistent with the grocery sector's sustainability goals.

COMPONENTS USED:

1. Arduino

Working: It serves as the central control which processes input from the users, controls servo, reads values coming from the load cell and displays messages on the LCD. Purpose: Coordinating all the components and making sure the logic of the system was implemented.
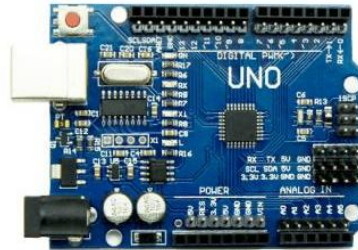

Figure.1 Arduino UNO

2. 4x4 Keypad

Function: A matrix keypad for user interaction, where users can input the desired weight for dispensing and password for access. Purpose: It offers a simple and effective way for users to interact with the system.

Figure.2 Keypad

3. I2C LCD Display

Function: A display module connected via I2C to the Arduino to show user input, error messages, and system status. Purpose: It reduces wiring complexity and allows for clear, real-time feedback to the user.

Figure .3   i2c LCD

4. 10kg Load Cell with HX711 Amplifier

Function: The load cell measures the weight of the dispensed groceries, while the HX711 is an analog-to-digital converter that amplifies and reads the signals from the load cell. Purpose: To ensure accurate weight measurements of the dispensed items to avoid over-dispensing or under-dispensing.

Figure.4 Hx711 Module

Figure. 5 10 Kg Load Cell

5. Servo Motor

Function: It controls the position of the dispensing mechanism by shifting to allow the flow of groceries. Purpose: Precisely opens or closes the dispensing mechanism based on user input to control the quantity of groceries dispensed.

Figure.6 Servo Motor

6. Wires

Function: Connects the electronic components all together, to ensure proper communication and power supply between the Arduino, keypad, load cell, servo motor, and LCD. Purpose: Enabling the passing of signals and power to the related components.

Figure.7 Wires

In this setup, simple yet efficient components are utilized, making my Automatic Grocery Dispenser cost-efficient and reliable to dispense just the right quantity of groceries hygienically and securely.

METHODOLOGY:

Automatic Grocery Dispenser is an automated, precise, and hygienic dispensing of groceries. The methodology comprises a set of sequential steps that integrate hardware components and logic in software to ensure the good working of the system. Here is more about the same:

1. System Initialization In this step, the Arduino microcontroller initializes all the components. These include 4x4 keypad, I2C LCD display, load cell with HX711 amplifier, and servo motor. The system runs a self-test to verify that all components are working properly and the LCD will display a welcome message asking to continue.

2. User input keypad interface In this interface, the user would interact with the system using a 4x4 keypad: It first asks the user to enter a password for verification. On entry of the correct password, the system grants him access and then proceeds to the weight input stage. If the password is wrong, the LCD shows an error message, and the user is asked to input the password again.

3. Desired Weight Input After authenticating, the user inputs the desired weight of groceries to be dispensed through the keypad. The input is shown on the I2C LCD, allowing the user to confirm their entry.

4. Activation of the Dispensing Mechanism Once the weight is confirmed: The servo motor moves to its position, exposing the hole in the stationary cap inside the hopper. Groceries start flowing through the hole due to gravity.

5. Weight Measurement The 10kg load cell with the HX711 amplifier continuously measures the weight of the dispensed groceries in real-time. The weight data is sent to the Arduino, which compares it to the user's input.

6. Real-Time Control As the weight of dispensed groceries approaches the desired value: The Arduino slows down the dispensing process (if programmed to fine-tune servo movements). Once the target weight is reached, the Arduino sends a signal to the servo motor to go back to its original position, which blocks the hole in the cap and stops the flow of groceries.

7. Error Handling If there is any discrepancy (e.g., groceries do not flow, or weight exceeds the target): The LCD alerts the user with an error message. The system may allow the user to retry or reset the operation.

8. User Input and Resetting After the fluid has been successfully dispensed, the LCD presents a completion message with the dispensed weight. The system will automatically reset ready for the next operation.

9. Sanitation and Safety The stationary cap ensures that the groceries are sealed and not contaminated until the servo motor opens up the hole. The password authenticating system controls access to limit

unauthorized entry hence safety. This methodology ensures a user-friendly, secure, and efficient system for dispensing groceries, with a strong focus on accuracy, hygiene, and automation.

Figure.8 Our Current Working Model

FLOWCHART OF OUR CURRENT WORKING MODEL:
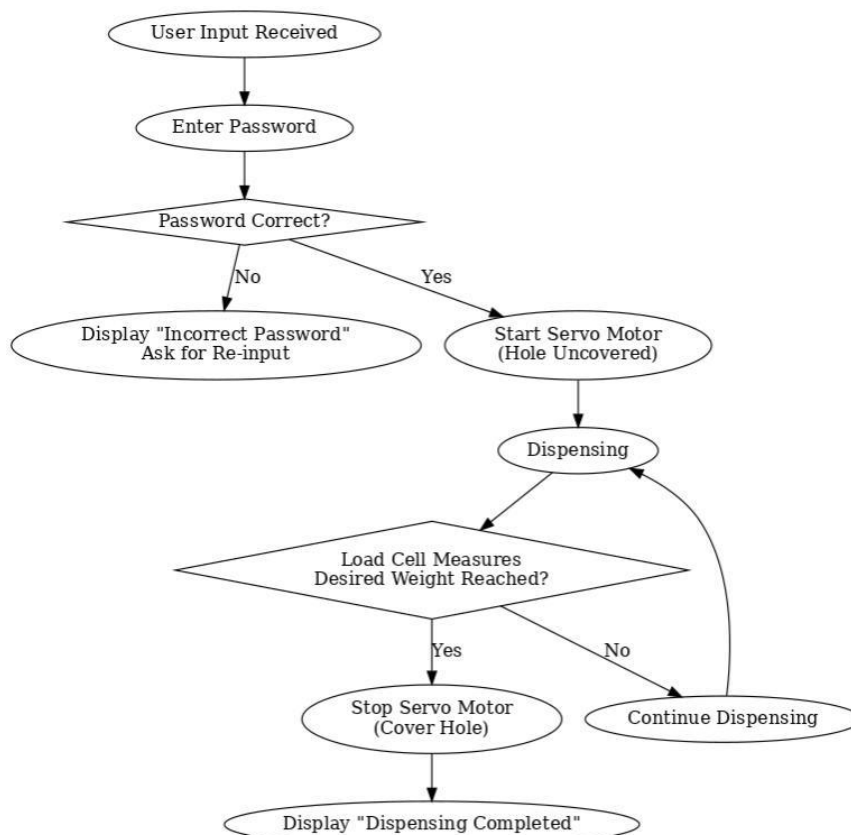
APPLICATIONS:
Retail Stores and Supermarkets

It allows for the accurate dispensing of grains, pulses, or cereals in bulk sections. It reduces manual handling, thus ensuring hygiene and accuracy.

Self-Service Kiosks

It allows customers to dispense the exact quantity of groceries they need without staff intervention.

Restaurants and Cafeterias

It automates the dispensing of rice, sugar, or other staples for consistent portion control in kitchens.

Smart Kitchens at Home

It provides an automated solution for daily grocery usage, such as measuring rice, lentils, or flour.

Public Distribution Systems

It ensures fair and accurate ration supply distribution in government schemes.

Food Manufacturing Units

It dispenses measured quantities of raw materials like flour or spices for production lines.

Agricultural Use

It dispenses seeds or animal feed in controlled amounts to avoid waste.

Charitable Food Distribution

Used in community kitchens or disaster relief centers to provide food supplies hygienically and efficiently.

ADVANTAGES:

1. Precision and Accuracy: Ensures exact measurement of groceries, reducing wastage.
2. Hygiene: Minimizes contamination by eliminating manual handling of groceries.
3. Automation: Streamlines the dispensing process, reducing human effort and errors.
4. User-Friendly Interface: Easy-to-operate system with a keypad and LCD display for real-time feedback.
5. Time-Saving: Dispenses groceries quickly and efficiently compared to manual methods.
6. Security: Password protection prevents unauthorized access.
7. Versatility: Handles a variety of granular items such as rice, pulses, sugar, and flour.
8. Scalability: Can be adapted for larger industrial or vending systems.
9. Environmentally Friendly: Encourages bulk purchasing, reducing single-use plastic packaging.
10. Cost-Effective in the Long Run: Reduces labor costs and grocery wastage over time.

DISADVANTAGES:

1. Maintenance Requirements: Regular calibration and upkeep are needed for components like load cells and servo motors to ensure accuracy.
2. Power Dependency: Requires a stable power supply, making it less effective in areas with frequent power outages.

CONCLUSION:

The Automatic Grocery Dispenser is an innovative solution that addresses the challenges of hygiene, precision, and efficiency in grocery handling and distribution. With its user-friendly interface, secure access, and accurate dispensing mechanism, it finds applications in retail, home kitchens, public distribution, and industrial processes. Despite minor challenges like power dependency and maintenance requirements, its benefits far outweigh the drawbacks. The dispenser stands as a significant step toward modernizing grocery management, ensuring sustainability and convenience in the process.

FUTURE SCOPE:

1. Voice Integration: Adding voice command functionality via virtual assistants like Alexa or Google
2. Assistant to enhance user interaction.
3. Multi-Item Dispensing: Expanding the system to dispense multiple items simultaneously or sequentially.

BIBLIOGRAPHY

1. https://doi.org/10.1155/2017/9013508
2. https://www.researchgate.net/publication/372496180_Automatic_Grocery_Vending_System
3. https://www.researchgate.net/publication/307662553_Automatic_Ration_Material_Distributions_Based_on_GSM_and_RFID_Technology
4. https://www.researchtrend.net/ijet/pdf/21-S-803.pdf
5. https://patents.google.com/patent/CA3009865A1/en