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DEVELOPMENT OF AUTOMATED RATION DISTRIBUTION SYSTEM

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ABSTRACT

The Public Distribution System (PDS) is an important government initiative designed to provide essential food commodities such as rice, wheat, sugar, and cooking oil to economically disadvantaged groups classified under APL and BPL categories. Despite its importance, the traditional ration distribution approach relies heavily on manual processes, which often results in issues such as incorrect measurement, lack of transparency, unauthorized diversion of resources, and inefficient record keeping. These problems lead to delays, unfair distribution, and dissatisfaction among beneficiaries.

To address these limitations, this project proposes an IoT-enabled Automated Ration Distribution System, referred to as the Ration Bot. The system integrates modern embedded technology with digital monitoring to ensure accurate and transparent ration delivery. The ESP32 microcontroller serves as the central processing unit, coordinating various hardware components including an RFID reader, load cell with HX711 amplifier, servo motor-operated butterfly valve, LCD display, and cloud connectivity platform. RFID-based identification confirms beneficiary authenticity and verifies their ration eligibility according to predefined categories.

The load cell ensures precise weight measurement of grains, while the servo-driven dispensing mechanism controls the flow of materials from the hopper. Automation significantly reduces human interference and improves accuracy during distribution. The system also records transaction data on a cloud platform, enabling real-time monitoring by authorities and providing instant notifications to users regarding their ration details. By combining IoT communication, automated dispensing, and secure authentication, the proposed system enhances reliability, minimizes malpractice, and supports digital governance initiatives. The Ration Bot provides a modern solution that improves fairness, efficiency, and accountability in the Public Distribution System.

Keywords: Public Distribution System, IoT, Smart Ration Shop, ESP32, RFID Authentication, Load Cell, Automated Dispensing, Embedded System, Cloud Monitoring, Digital Governance.

INTRODUCTION

Ensuring food availability to economically weaker communities is one of the key objectives of the Public Distribution System (PDS). Through this scheme, subsidized food materials such as rice, wheat, sugar, and oil are supplied to eligible citizens categorized under APL and BPL groups. Although the system aims to distribute food fairly, existing ration shop operations mainly depend on manual handling, which creates multiple operational challenges. Common issues include inaccurate weighing, unauthorized diversion of ration materials, record manipulation, delays in service, and limited monitoring capabilities. As a result, many beneficiaries do not receive their full quota, reducing trust in the distribution system.

With the rapid development of embedded systems and Internet of Things (IoT) technologies, it has become possible to automate traditional systems and improve their performance. The Automated Ration Distribution System proposed in this work integrates identification, measurement, dispensing, and monitoring functions into a single smart unit. The ESP32 microcontroller is used as the main control device due to its processing capability and built-in Wi-Fi feature, making it suitable for IoT applications.

The system utilizes RFID technology to uniquely identify beneficiaries and confirm their eligibility. Accurate measurement of ration materials is achieved using a load cell sensor connected to an HX711 amplifier. The dispensing mechanism consists of a servo motor connected to a butterfly valve that regulates grain flow from the hopper. An LCD screen provides real-time feedback to the user regarding system status and quantity dispensed.

Additionally, transaction details are transmitted to a cloud-based platform, allowing remote monitoring and digital record maintenance. Beneficiaries also receive notifications regarding ration distribution. By minimizing manual intervention, the system improves transparency, accuracy, and efficiency in ration distribution, supporting the concept of smart governance.

LITERATURE REVIEW

Researchers have extensively studied the limitations of the traditional Public Distribution System, particularly issues related to corruption, inaccurate measurements, and lack of proper monitoring. Several technological solutions have been proposed to enhance transparency and efficiency in ration distribution processes. Many studies have explored the use of digital identification systems such as RFID cards or smart cards to prevent misuse of ration cards and ensure that only eligible users receive benefits.

Initial research efforts mainly focused on improving beneficiary identification through electronic authentication systems. Although these approaches helped reduce identity fraud, the ration dispensing process still depended on manual measurement methods, which could lead to inaccurate distribution.

Later studies introduced electronic weighing technologies using load cell sensors to improve measurement precision. By integrating load cells with microcontrollers, researchers demonstrated improved accuracy in ration quantity measurement. Some designs also incorporated servo motors or motorized valves to automate grain dispensing, thereby reducing human errors.

With advancements in IoT technology, researchers started integrating cloud-based monitoring systems and GSM communication modules into ration distribution frameworks. These solutions enabled remote tracking of transactions and improved record management. Real-time notifications also enhanced transparency for beneficiaries.

Recent developments emphasize the integration of identification, automated measurement, dispensing control, and digital monitoring within a single system. Combining RFID authentication, load cell-based weight measurement, servo-controlled dispensing mechanisms, and IoT-based cloud connectivity provides a comprehensive approach for improving reliability and accountability in ration shops. The proposed system is developed based on these research advancements, focusing on simplicity, affordability, and practical implementation.

METHEDOLOGY

1. POWER SUPPLY AND VOLTAGE REGULATION

All electronic modules in the system require a stable power source for proper functioning. Components such as ESP32, RFID reader, load cell amplifier, servo motor, and LCD display operate at specific voltage levels. Variations in voltage may cause incorrect sensor readings or hardware damage. The system uses a regulated DC power supply to convert AC mains voltage into a stable DC output. A voltage regulator maintains constant voltage levels such as 5V or 3.3V required for proper operation of electronic components. Stable power ensures reliable performance of sensors and communication modules.

2. ESP32 MICROCONTROLLER

The ESP32 acts as the main controller of the system, managing data processing, sensor communication, actuator control, and cloud connectivity. It is selected because it provides multiple input-output pins along with built-in Wi-Fi capability, making it suitable for IoT-based automation systems.The ESP32 receives input data from the RFID reader and load cell sensor. Based on authentication results, it controls the servo motor to regulate grain dispensing. It also sends transaction details to the cloud platform for monitoring purposes.

Fig:- ESP32 microcontroller

3. RFID READER FOR AUTHENTICATION

The RFID reader is used in the Ration Bot system to provide secure and reliable authentication of beneficiaries. In traditional ration shops, identification is done manually using ration cards, which can be misused, duplicated, or manipulated. To overcome this issue, RFID technology is introduced to uniquely identify each user and ensure that only authorized beneficiaries receive ration.

Each beneficiary is provided with an RFID card that contains a unique identification number. When the card is brought near the RFID reader, the reader detects the card and sends the unique ID to the ESP32 microcontroller. The ESP32 then verifies this ID with the stored database to check whether the user is eligible to receive ration and whether their monthly quota is available. If the details are valid, the system proceeds to the dispensing process. If the card is invalid or the quota is already exhausted, the system denies access and displays an appropriate message on the LCD

Fig:- RFID READER

4. LOAD CELL AND LOAD CELL AMPLIFIER (HX711)

Accurate measurement of ration materials is achieved using a load cell sensor. The load cell detects weight changes when grains are collected in the container. The electrical signal generated by the sensor is very small and requires amplification. The HX711 module amplifies the signal and sends digital weight data to the ESP32. This ensures precise measurement and prevents errors associated with manual weighing.

Fig:- load cell

5. SERVO MOTOR AND BUTTERFLY VALVE MECHANISM

Automatic dispensing of grains is achieved using a servo motor connected to a butterfly valve positioned at the hopper outlet. When the ESP32 confirms user authentication, the servo motor rotates to open the valve and allow grains to flow.The load cell continuously monitors weight, and once the desired quantity is reached, the ESP32 instructs the servo motor to close the valve. This mechanism ensures controlled dispensing and prevents excess distribution.

Fig:- Servo motor

6. LCD DISPLAY FOR USER INTERFACE

The LCD module provides information regarding system status and ration quantity. Messages such as card verification results, dispensing progress, and completion confirmation are displayed to the user.This improves system usability and increases transparency during the distribution process. The LCD module provides information regarding system status and ration quantity. Messages such as card verification results, dispensing progress, and completion confirmation are displayed to the user.This improves system usability and increases transparency during the distribution process.

7. MOBILE APPLICATION INTERFACE

Fig :- LCD Display

The system connects to the Blynk IoT platform ɔrovided by the ESP32. Transaction details including user identification, quantity dispensed, and time of transaction are uploaded to the cloud. Authorities can monitor system activity remotely, while beneficiaries receive notifications about ration transactions. Digital record maintenance improves accountability and prevents data manipulation.

ALGORITHM :

1. Start and initialize ESP32, LCD, RFID reader, load cell (HX711), servo motor, and Wi-Fi.
2. Display “Scan RFID Card” on LCD.
3. Read RFID and verify status (X).
4. If X = 0 → Invalid card → buzzer ON → return to Step 2.
5. If X = 1 → proceed.
6. Check user ration eligibility (Y).
7. If Y = 0 → No quota → return to Step 2.
8. If Y = 1 → proceed.
9. Open butterfly valve using servo motor.
10. Continuously monitor weight from load cell.
11. When preset weight is reached, close the valve.
12. Display “Dispensing Completed” on LCD.
13. Upload transaction data to cloud and notify user.
14. Reset system and wait for next user.
15. Stop.

ADVANTAGES

- Provides precise measurement of ration materials
- Reduces chances of corruption and misuse
- Improves transparency in distribution process
- Minimizes manual effort
- Enables digital record maintenance
- Provides real-time monitoring capability
- Suitable for both rural and urban environments
- Easy to operate and maintain

CONCLUSION

The Automated Ration Distribution System offers an improved approach to managing food distribution through the integration of embedded systems and IoT technology. By replacing manual processes with automated identification, measurement, and dispensing mechanisms, the system enhances accuracy and reliability. RFID-based authentication ensures that only eligible beneficiaries receive ration, while the load cell guarantees precise quantity measurement. The servo-controlled valve provides controlled dispensing, eliminating human errors. Cloud connectivity allows secure storage of transaction data and enables remote monitoring by authorities. The proposed system promotes transparency and minimizes malpractices commonly observed in traditional ration shops. Beneficiaries receive correct ration quantities along with digital confirmation of transactions. The solution contributes to modernization of the Public Distribution System and supports efficient delivery of essential commodities.

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