IES International Journal of Multidisciplinary Engineering Research

Smart Ration Distribution System

Abishek K.S [1], Mohammed Hashir [2], Farhana Habeeb [3], Sindhu T.V [4]

[1, 2, 3] *Student, Electronics & Communication Engineering, IES College of Engineering, Kerala, India*

[4] *Assistant Professor, Electronics & Communication Engineering, IES College of Engineering, Kerala, India*

Email_id: abishekksachu@gmail.com, farhanahabeeb7@gmail.com,hashirshiru916@gmail.com, sindhutv@iesce.info

Abstract

The Smart Ration Distribution System (SRDS) represents an innovative approach to enhancing the transparency, efficiency, and accessibility of public ration distribution. Leveraging cutting-edge technologies such as the Internet of Things (IoT), cloud computing, and real-time data analysis, the SRDS enables the fair and effective allocation of essential goods without depending on traditional RFID or GSM methods. The system employs smart ration cards connected to a centralized database, providing real-time tracking of entitlements, consumption patterns, and stock levels. At distribution points and storage facilities, sensors are installed to automate stock monitoring, ensuring timely replenishment and minimizing the risk of shortages. The inclusion of data analytics further allows for the detection of discrepancies, reducing fraudulent practices, and improving system transparency. A user-friendly platform empowers beneficiaries to check their entitlements and ration status while offering a quick resolution mechanism for grievances. By automating processes and eliminating intermediaries, SRDS improves the efficiency of ration distribution, reduces delays, and guarantees that essential goods reach those who need them fairly and without hindrance.

Keywords: Internet of Things (IoT), cloud computing, RFID, GSM methods

DOI: https://doi.org/10.5281/zenodo.15128435

1. Introduction

The Smart Ration Distribution System (SRDS) offers a transformative solution to address the inefficiencies, fraud, and mismanagement common in conventional public distribution systems (PDS). Its primary goal is to ensure the timely, fair, and transparent delivery of essential goods to marginalized populations, particularly low-income families. By integrating technologies like IoT, cloud computing, and real-time data analytics, SRDS overcomes the challenges of traditional PDS and provides a more effective and accountable method of distribution. Traditional systems face issues such as stock theft, misallocation, and delayed deliveries, compounded by manual record-keeping and outdated processes. SRDS eliminates the need for physical tokens or intermediaries, which are often vulnerable to error or manipulation, and instead utilizes a network of intelligent devices to monitor inventory levels, providing real-time insights into stock availability.

Smart ration cards assigned to beneficiaries are linked to a centralized database that maintains up-to-date records of transactions, including ration entitlements and usage. These cards ensure that only authorized

individuals receive the goods allocated to them, helping to authenticate recipients and minimize human error. Additionally, a digital platform enhances transparency, allowing beneficiaries to monitor their ration status, verify entitlements, and lodge complaints if required. This open and accessible system not only reduces delays but also builds trust in the public welfare system.

The SRDS further integrates predictive analytics to forecast demand trends, identify bottlenecks, and alert authorities to potential stock shortages before they occur, enabling better planning and resource allocation. The system also reduces food waste and optimizes resource use through automated stock management. With the use of IoT sensors and cloud storage, SRDS can be scaled to serve both urban and rural areas effectively, making it a practical solution for diverse geographic and economic environments. It is adaptable to include renewable energy sources in areas with limited electricity access, contributing to the sustainability of the system. In essence, SRDS aims to modernize the distribution of essential goods, creating an equitable, transparent, and efficient platform that benefits both governments and citizens. It helps ensure the fair allocation of resources while contributing to the establishment of a robust, fraud resistant public distribution system.

2. Objectives

The objectives of the Smart Ration Distribution System are as follows:

The system aims to enhance the security and efficiency of ration distribution by integrating RFID-based authentication and biometric verification. It seeks to reduce fraudulent activities by ensuring that only rightful beneficiaries can access their entitlements. The incorporation of IoT technologies allows real-time monitoring of stock levels, improving inventory management and reducing shortages. Additionally, mobile applications will be developed to enable users to check ration balances and receive notifications, fostering greater user engagement. The system also aims to promote sustainability by optimizing delivery routes and using eco-friendly packaging. Future enhancements include blockchain technology to ensure transparency and prevent data tampering. Furthermore, the project envisions collaborations with governments and NGOs to tailor the system to local needs, expanding its application beyond ration distribution to other welfare programs such as healthcare and education.

3. Exiting Project's

1. **Implementation of Smart Ration Distribution and Controlling System:** This project introduces a scalable system utilizing smart cards and GSM technology to automate ration distribution, aiming to reduce inaccuracies, long waiting times, and material theft prevalent in traditional systems.
2. **IoT-Based Smart Ration Distribution System:** This system replaces traditional ration cards with RFID tags verified through IoT technology, aiming to create a more secure and efficient distribution process for subsidized commodities.
3. **Smart Ration Card and Ration Distribution System Using RFID and IoT:** This project proposes an automation system that integrates RFID and IoT technologies to enhance security and transparency in ration distribution. Fingerprint authentication is employed to eliminate fake ration cardholders and ensure accurate distribution.

4. **E-Ration Distribution System Based on QR-Code:** Addressing fraudulence in existing systems, this project proposes an e-ration distribution system utilizing QR codes to improve efficiency and transparency in the public distribution system.

5. **Automatic Ration Distribution System Using RFID Technology:** This project integrates RFID technology with Arduino microcontrollers to create an efficient and secure system, ensuring fair distribution of ration supplies.

4. Proposed System

The Smart Ration Distribution System (SRDS) is an advanced solution designed to overcome inefficiencies and fraud in traditional public distribution systems. It integrates biometric authentication, IoT-based stock monitoring, automated ration dispensing, and cloud-based data management to ensure transparency, accuracy, and efficiency. Beneficiaries authenticate themselves using a fingerprint sensor linked to a centralized database, preventing fraudulent access. The system employs IR sensors and water level sensors to monitor stock levels in real-time, ensuring timely replenishment and preventing shortages. Automated dispensing mechanisms, controlled by servo motors and solenoid valves, precisely distribute rations with minimal human intervention. A cloud-based platform records transactions, while a mobile app allows users to check entitlements, receive notifications, and register grievances. By eliminating manual errors, reducing corruption, and streamlining ration distribution, SRDS significantly improves accessibility and trust in public welfare programs. Future enhancements, such as blockchain integration and AI-based demand forecasting, can further strengthen its effectiveness and scalability.

5. Literature Review

Several researchers have explored ways to improve the Public Distribution System (PDS) through automation, aiming to reduce corruption, inefficiencies, and manual errors. This section provides an overview of some of the key works in this area.

S. Sukhumar (2018) introduced an Automatic Ration Material Distribution System based on GSM and RFID technology. The study highlights how the traditional PDS faces issues like corruption and illegal trafficking due to its dependence on manual processes. The proposed system aims to automate ration distribution, reducing human intervention and ensuring transparency.

Md. Amanul Haque (2020) discussed an Automated E-Ration Distribution System. His work emphasizes that India's PDS is one of the largest retail networks in the world, designed to provide food security by offering essential commodities at subsidized rates. The study focuses on improving the distribution process by using digital solutions to prevent fraud and ensure fair allocation.

Priya B (2021) proposed an Automatic Public Distribution System for Digital India, which utilizes smart cards to streamline ration distribution. The paper highlights how this system can minimize corruption and improve efficiency, ultimately benefiting over 33 crore people in India who rely on PDS for essential food supplies.

Vaibhav Avasthy (2022) explored a Ration Distribution System Based on RFID Technology. The study addresses common problems faced by consumers, such as long waiting times and inventory mismanagement. By integrating RFID technology, the system enables real-time stock updates and sends SMS notifications to users, making ration distribution more transparent and efficient.

Sriram Selvaraju (2013) examined the drawbacks of traditional ration distribution, such as inaccurate weight measurements due to human error and the illegal resale of unclaimed goods. His research suggests using GSM and RFID technologies to automate the process, ensuring fair and transparent distribution of essential commodities.

Shubha Jain (2018) proposed an RFID-Based Food Rationing System, focusing on the importance of ration cards for Indian households. The study highlights existing challenges in the current system and suggests an RFID-based solution to enhance accuracy and prevent misuse.

Amrutha Nair (2021) introduced an IoT-Based Smart Public Distribution System, aiming to modernize the PDS using internet-connected devices. The paper discusses how IoT can help track inventory, monitor transactions, and improve accessibility for beneficiaries.

Rahul K (2019) conducted a survey on Advanced Ration Distribution Systems, analyzing various methods India has adopted to combat malpractices in ration distribution. His research provides insights into different technological solutions that can improve transparency and efficiency.

Overall, these studies demonstrate that integrating technology into the Public Distribution System can significantly enhance its effectiveness, ensuring that essential commodities reach the intended beneficiaries without delays or corruption.

6. Material

Integrating the ESP32 microcontroller with a fingerprint sensor and a buck converter facilitates the creation of a Smart Ration Distribution System that is both secure and energy-efficient. The ESP32 serves as the central processing unit, managing biometric data processing, user authentication, and communication between system components. Fingerprint sensors, such as the R307 model, capture and verify beneficiaries' fingerprints to ensure secure and accurate identification. To interface the ESP32 with the R307 fingerprint sensor, you can follow the guidelines provided in this tutorial.

The buck converter efficiently steps down the input voltage (e.g., 12V) to the 3.3V required by the ESP32, ensuring a stable and efficient power supply. However, it's crucial to ensure that the buck converter delivers a stable 3.3V output to prevent system instability, as voltage ripple can cause the ESP32 to reboot or malfunction. A user-friendly interface comprising an LCD display and input buttons allows beneficiaries to interact with the system, select items, and input necessary information.

Automated dispensing mechanisms, including servo motors and solenoid valves, handle the release of ration items based on user selections. Servo motors precisely control the dispensing of solid items, while solenoid valves regulate the dispensing of liquid commodities accurately. This automation minimizes human intervention, reduces errors, and ensures that rations are distributed based on identified needs, promoting fairness and equity.

Implementing such a system requires reliable technological infrastructure, including stable power supply and connectivity, to support its operation effectively. Ensuring that the buck converter delivers a stable 3.3V output is essential to prevent system instability, as voltage ripple can cause the ESP32 to reboot or malfunction. Additionally, the fingerprint sensor should be calibrated to ensure accurate recognition under various environmental conditions.

7. Circuit Diagram

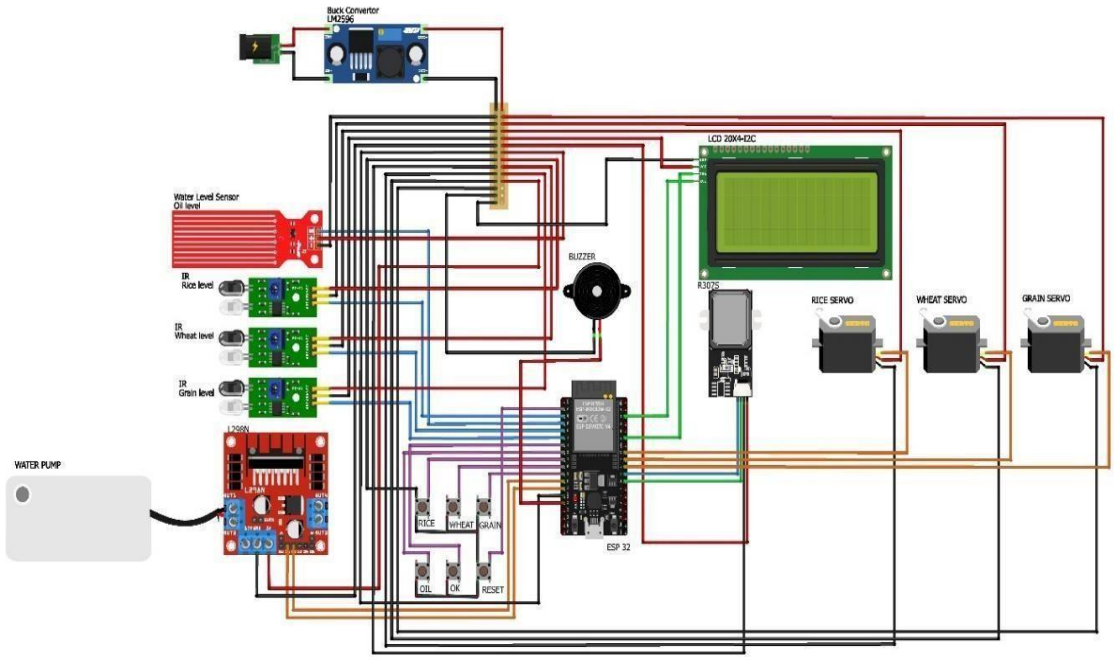

Figure 1: Circuit Diagram

This schematic diagram represents an automated ration distribution system using an ESP32 microcontroller. Here's a detailed explanation of the components and their roles in the system:

- **Main Components and Their Functions**

1. **ESP32 Microcontroller**: Acts as the brain of the system, controlling all sensors, actuators, and displays. Receives inputs from sensors and buttons to trigger outputs like servos, water pumps, etc.
2. **Power Supply System:** A Buck Converter (LM2596) is used to step down the voltage to 5V for powering ESP32 and other components.
3. **Sensors:** Water Level Sensor: Detects the oil level.
4. **LCD Display (20x4 I2C):** Displays the system status, item levels, and prompts for user actions.
5. **Buzzer:** Provides audio alerts for various conditions (e.g., empty container, successful dispensing).

6. **Motors and Actuators:** Servos (x3): Control the dispensing mechanism for rice, wheat, and grains. Water Pump: Dispenses liquid (oil or water) when triggered.
7. **L298N Motor Driver**: Drives the water pump by controlling motor direction and speed.
8. **R307S Fingerprint Module:** Provides user authentication to ensure secure ration dispensing.
9. **Push Buttons**

   Various buttons for:

   RICE, WHEAT, GRAIN: To request a particular item.

   OIL, OK, RESET: For additional control actions.

- **Working Principle**

1. **Power Supply:** The system is powered through the Buck Converter, which steps down voltage for ESP32 and other peripherals.
2. **Input Detection:** The IR sensors monitor the levels of rice, wheat, and grains. The water sensor detects oil levels. If any container is low, alerts are triggered on the LCD.
3. **User Interaction:** Users select the desired item via push buttons. The ESP32 processes this input and triggers the corresponding servo motor to dispense the item.
4. **Authentication (Optional):** The R307S fingerprint module can validate user identity before allowing dispensing.
5. **Dispensing Mechanism:** The activated servo motor opens the respective container's outlet to dispense the requested ration.
6. For liquids like oil, the ESP32 activates the L298N motor driver, which controls the water pump.
7. **Alerts and Display:** The buzzer sounds if errors occur (like an empty container), and the LCD provides real-time status updates.

8. Result

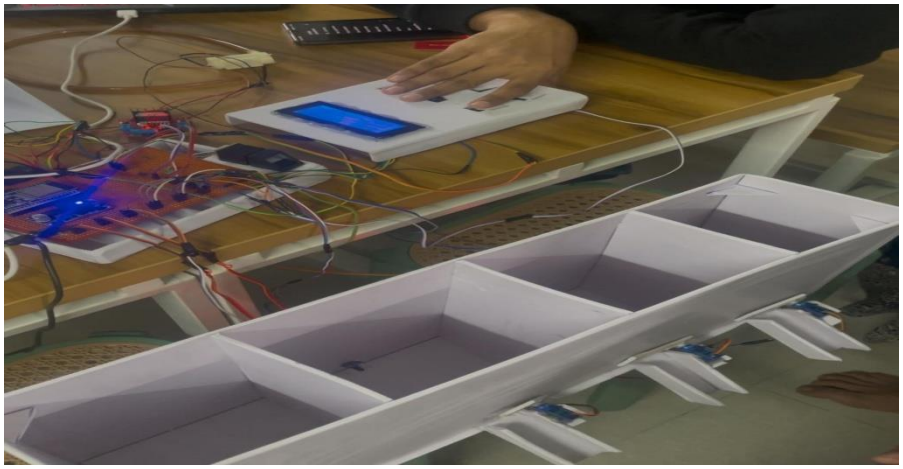

Figure 2: Result

9. Conclusions

The Smart Ration Distribution System, built around the ESP32 microcontroller, fingerprint sensor, and buck converter, offers an efficient, secure, and automated solution for distributing essential goods. The use of biometric authentication ensures that only eligible beneficiaries receive their rations, minimizing errors and fraud. Automated dispensing mechanisms ensure accurate and fair distribution of both solid and liquid items. The system promotes transparency, reduces human error, and provides real-time monitoring for enhanced accountability. Its sustainable design, featuring energy-efficient components, ensures long-term viability, making it an excellent choice for both urban and rural areas. Ultimately, SRDS has the potential to revolutionize public welfare systems by improving service delivery while maintaining integrity and transparency

References

[1]. S. Sukhumar, Gopinathan, Kalpanadevi Naveenkumar, Automatic Ration Material Distribution Based On GSM and RFID Technology (2018). Vanitha. https://www.ijates.com/images/short_pdf/1489477871_S3002.pdf

[2]. Md Amanul Haque, Dhrubangshu Gupta,Manya Sharma, Santhosha. Automated E-Ration Distribution System (2020). , https://www.irjet.net/archives/V7/i7/IRJET-V7I7802.pdf

[3]. Automatic Public Distribution System for Digital India (2021)., by Priya B. Gaik wad, Prof.Sangita, H.Nikumbh S https://www.irjet.net/archives/V8/i2/IRJET-V8I226.pdf

[4]. Automatic Ration Distributions Based on RFID Technology (2022). by Vaibhav Avasthy, Dr.S.Rekha https://www.researchgate.net/publication/380702709_Automatic_Ration_Distributions_Based_on_RFID_Technology

[5]. Automatic Ration Material Distributions Based on GSM and RFID Technology. (2013), by Raghav Ramani, Sriram Selvaraju https://www.sciencedirect.com/science/article/pii/S2468067217300329

[6]. RFID-based food rationing system (2018). by Rakesh Kumar Jha, Yamini Sri vastav,Vedika Sumbli, risha, Vidula Gandhi,Shubha Jain https://www.sciencedirect.com/science/article/pii/S2468067217300329

[7]. A Proposed Model for Smart Public Distribution System of Ration Commodities to Indian Citizens using an IoT based Design. (2021) by Amrutha Nair,Shaikh MohammadBilal Naseem https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3866198

[8]. A Survey On Advanced Ration Distribution System. (2019) by Elshaama V W,Vidya B,Rahul K,Trupti https://www.irjet.net/archives/V6/i4/IRJET-V6I41140.pdf

[9]. Survey on Automatic Ration Distribution System (2023) by Adithya B Anil, Akshay S R, Arathi V R, Gouri

[10]. Parvathi R, and Visakh R https://www.ijirset.com/upload/2023/may/144_Literature_NC.pdf

[11]. E-Ration Management System. (2024) by S A Mathanraj, Mr. J. Jayapandian,, https://ijrpr.com/uploads/V4ISSUE6/IJRPR14558.pdf

[12]. Automatic Rationing Distribution System (2017) by Dr. Jillella Venkateswara Rao https://ijarse.com/images/fullpdf/1487605373_G1063ijarse.pdf

[13]. Automatic Ration Dispensing System (2020) by Dr Satish H C https://www.ijert.org/research/automatedrationmaterial-distribution-system-IJERTCONV6IS13221.pdf

[14]. Automated Ration Distribution Using RFID. (2023) by Anuga Shreya Reddy,Divya Shamlet https://ijcrt.org/papers/IJCRT2312778.pdf

[15]. Automated Ration Material Distribution System (2018) by Srinivas, Hebbar, San jana, Kumar, Shreyas https://www.ijert.org/research/automated-ration-material-distribution-system-IJERTCONV6IS13221.pdf

[16]. Automated Ration Distribution System (2013) by JianliGoradiaa, Sarthak Doshib https://www.researchgate.net/publication/277568368_Automated_Ration_Distribution_System