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Automatic Ration Vending Machine Using RFID and GSM Techniques

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Abstract

The ration card plays a key role in helping families access essential food supplies at subsidized rates. However, the traditional distribution process often faces problems such as incorrect quantity delivery, lack of monitoring, and misuse by intermediaries. This work presents an automatic ration vending system that uses RFID for identifying users and GSM technology for communication. The system ensures that only eligible users can receive their allocated ration and that the quantity delivered is accurate. By reducing human involvement, the proposed system increases efficiency, transparency, and reliability in ration distribution.

Introduction

The Public Distribution System (PDS) is designed to supply basic food items to people at controlled prices. In a country with a large population, maintaining such a system efficiently is difficult. Issues like unfair practices, inaccurate weighing, and lack of proper tracking reduce the effectiveness of the system.

In many cases, beneficiaries do not receive their full share of food grains due to inefficiencies in manual handling. This creates a need for a smarter and more reliable system.

To improve the existing process, this project introduces an automated ration distribution system using RFID technology. The aim is to ensure that only authorized users can access ration materials and that distribution is carried out accurately and transparently.

Literature Review

Semi-Automated Ration Distribution (Panzade & Wanode, 2023)

Used RFID + GSM + OTP for user authentication, transaction security, and real time stock monitoring. Improved efficiency, transparency, and accountability, but still required manual dispensing and was dependent on mobile network availability.

Automatic Ration Vending Machine (IJCRT, 2023)

Implemented RFID-based user identification with automated dispensing and digital transaction records. Enhanced accuracy and reduced corruption, but lacked biometric verification and real time monitoring.

Shrikrishna Huilgol & Sivapuram Ramarohith (IRJET,2022)

Proposed an automated ration machine using

RFID authentication and GSM alerts. Emphasized error-free distribution and quota tracking with user verification.

Srinivas Hebbar et al. (IJERT, 2018)
Developed a system for automated material dispensing using microcontrollers. Focused on reducing manual intervention and improving system reliability.

Abhirup Kar et al. (IJAREEIE,2018)
Introduced an RFID-based system to eliminate corruption in ration distribution. Incorporated GSM for sending transaction updates to users and authorities. Highlighted low-cost implementation and ease of integration with existing systems.

Methodology

1. Hardware/Software for Data Collection Module

Input Data needed:

- RFID Tag ID: 12 digit unique code given to each user
- User Quota Data: Predefined limits of items (e.g., rice, wheat) for each user per month
- Mobile Number: To send SMS alerts via GSM module
- Dispensed Quantity: Measured using weight sensors (load cell)

Data Format:

- RFID Tag:12-chracter hexadecimal string
- Quota Information: Stored in EEPROM or interfaced external memory in tabular format
- SMS Data: Text format for message body
- Transaction Logs: Stored in microcontroller memory or external EEPROM as structured records

Sources Of Data:

- RFID reader: Scans user tag
- Predefined EEPROM Memory: Contains user quota and identification data
- GSM Module (SIM900 or equivalent): Sends/receives SMS
- Load cell with ADC: Provides analog weight data converted to digital format

Technique to Collect, Arrange and Process Data:

- RFID reader connected to 8051 microcontroller via UART reads the tag
- 8051 matches tag ID with user data stored in memory
- 8051 allows dispensing via motor control
- Load cell data is processed via an ADC module and verified against quota
- GSM module communicates via UART to send SMS
- All logic is implemented in embedded C, compiled using Keil uVision IDE

2. Hardware/Software Development Module

Project Modules and Their Functions:

- RFID Authentication Module:
- Reads RFID tag
- Verifies against stored user IDs
- Grants or denies access

User Quota Management Module:

- Stores individual user quota in EEPROM
- Updates remaining quota after each transaction

Dispensing Control Module:

- Operates motor through driver circuit
- Dispenses item until weight matches quota

Weight Measurement Module:

- Load cell converts analog weight to digital
- MCU compares measured weight with allowed quota

GSM Notification Module:

- Sends SMS via SIM900 connected to serial port of 8051
- Message includes item dispensed and remaining quota

LCD Display Module:

- 16x2 LCD connected to 8051
- Shows user ID, item dispensed and status message

Software Details:

- Language: Embedded C
- Compiler: Keil µVision
- Burner Tool: Flash magic for dumping code into 8051
- Simulation tools: Proteus for circuit design and simulation

3. Hardware/Software Training and Testing Module:

Testing Parameters:

- Accuracy of RFID detection
- Correctness of Dispensed Quantity
- Response Time from RFID scan to Dispensing
- Reliability of SMS notification system
- Stability of Power Supply and Components

Testing Methods:

- Unit Testing: Individually test RFID ,GSM and load cell modules
- Integration Testing: Combine all modules and test end-to-end functionality
- Dry run Testing: Simulate user

transactions without actual dispensing
- Boundary Testing: test with minimum and maximum quota values
- Error Condition Testing: RFID not recognized, GSM not responding, low inventory

Testing Strategies:
- Use debugging via serial port monitor for real time data observation
- Maintain test logs for each user interaction
- Measure actual weight dispensed vs expected using digital scale
- Check GSM delivery reports for SMS validation

System Architecture

The system architecture consists of both hardware and software components integrated to perform automated ration distribution.

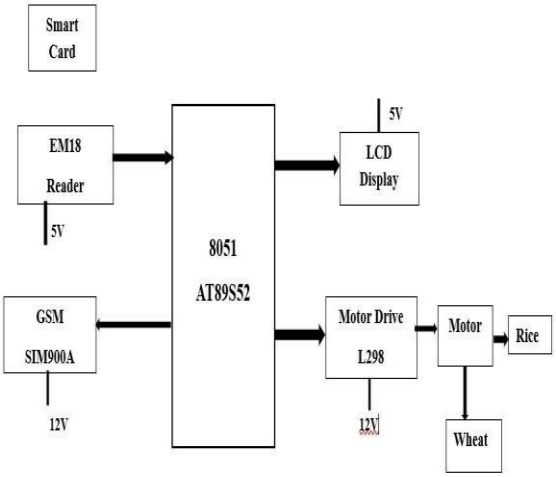

Figure 1. Block Diagram of RFID and GSM-Based Automatic Ration Vending System

Working:
- The user scans their RFID cards at the RFID reader
- The system verifies the user details from the database
- If authenticated, the available ration quantity is displayed
- The user selects the required commodity using the keypad
- The microcontroller activates the motor to dispense the ration
- The load cell measures the exact quantity dispensed
- GSM module sends a confirmation message to the user
- The database is updated automatically

User Authentication & Profile Management Module:

This module serves as the system's main security checkpoint, ensuring that only verified users are permitted to access its services.
- Uses RFID cards for user identification
- Each user has a unique ID linked to their ration details
- Prevents unauthorized access and fraud
- Stores user data such as quota and transaction history

Input & Selection Module:
- This component enables users to interact with the system and choose the desired items conveniently.
- Includes keypad for user input
- Displays available ration on LCD screen
- Allows selection of item and quantity
- Provides user-friendly interface

Processing & Control Module:
- This is the core module (brain of the system).
- Implemented using microcontroller (Arduino/8051)
- Processes RFID data and user input
- Verifies user eligibility and available quota
- Controls all hardware components
- This module performs decision-making and system control.
- Ration Dispensing Module:
- This module handles the physical distribution of ration items.
- Uses DC motor and motor driver
- Dispenses items
- Works based on commands from microcontroller
- Ensures automated and controlled delivery
- It replaces manual ration distribution with automation.

Weight Measurement Module:
- This module ensures accurate quantity dispensing.
- Uses load cell (weight sensor)
- Continuously measures dispensed quantity
- Stops motor when required weight is reached
- Minimizes errors and wastage
- This module ensures precision and fairness.

Communication (GSM) Module:
- This module provides real-time communication with users.
- Sends SMS alerts after each transaction
- Includes details like quantity and remaining balance
- Works using GSM network

- Enhances transparency and trust
- It keeps users informed and maintains records.

Display & Notification Module:

- This module delivers visual information and feedback to the user.
- Uses LCD display
- Shows user name, available quota, and status
- Displays system messages (success/error) It improves usability and user experience.
- Power Supply Module:
- This module provides required power to the system.
- Converts AC to regulated DC supply
- Ensures stable operation of components
- Includes voltage regulators
- Essential for continuous and reliable system operation.

Result Analysis

Figure 2. Prototype Implementation of Smart Automatic Ration Distribution Machine

Accuracy of Ration Distribution

The system demonstrated high accuracy in dispensing ration due to the use of load cell sensors. The error margin was observed to be minimal (within acceptable limits), ensuring fair distribution of commodities.

Authentication Efficiency

RFID-based authentication was fast and reliable. Each user was successfully identified within a few seconds, reducing waiting time and preventing unauthorized access.

GSM Communication Performance

The GSM module effectively delivered SMS notifications to users once transactions were completed.

System Response Time

The overall system response time—from RFID scanning to ration dispensing—was efficient and user-friendly. The average processing time was approximately 5–10 seconds.

Reliability and Stability

The system operated continuously without major failures during testing. Hardware components such as motors and sensors showed stable performance.

Reduction in Fraud and Errors

Automation significantly reduced manual errors and fraudulent activities. Since all transactions were recorded digitally, transparency was improved.

User Satisfaction

Users found the system easy to use and appreciated the transparency and SMS alerts. The keypad and display interface made interaction simple.

Comparative Analysis with Traditional System

- Compared to manual ration shops:
- Faster service
- Improved accuracy

Challenges And Limitations

1. Security Limitations

- Lack of Biometric Authentication: Most systems rely only on RFID cards, which can be lost, duplicated or misused.
- OTP dependency on mobile networks: Systems using OTP are not reliable in rural or low signal areas, which can delay or block transactions.
- RFID-Only authentications is insufficient for high security environments without a secondary validation .

2. Hardware; Dispensing limitations

Manual dispensing still required in many systems, defeating full automation and allowing for potential human manipulation or errors. No real-time weight feedback in some setups; Absence of load cells or sensors can lead to inaccurate quantity dispensing.

Lack of Servo motor integration in older or simpler systems results in poor control over dispensing mechanisms.

3. Network; Infrastructure limitations

Dependency on GSM/Mobile networks for sending OTPs Or alerts poses challenges in areas

with poor connectivity.
No cloud-based integration in many designs, limiting real-time monitoring, centralized control, and policy analytics.
Systems lacking IOT capabilities cannot perform remote stock monitoring or alerting to authorities.

4. Operational limitations

High setup cost for full automation makes implementation difficult in low-budget or rural contexts. Inadequate user feedback systems result in a lack of transparency for end users.

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