

Voice Based Food Dispensing System

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Abstract

Automation technologies are increasingly being adopted to enhance comfort, security, and accessibility in everyday environments. This study presents the design and development of a voice-enabled smart food dispensing system integrated with RFID authentication and assistive features for visually impaired individuals. The main objective of the proposed system is to provide a secure, automated, and accessible mechanism for dispensing food while supporting different user groups through multiple access methods. The system is built around a microcontroller-based architecture that integrates several technologies, including RFID modules, RF transmitter–receiver communication, GSM notification systems, and voice feedback units. In the standard operational mode, users authenticate themselves using RFID cards, allowing the system to verify identity and activate the dispensing mechanism. For visually impaired users, an assistive mode is implemented in which a portable RF transmitter carried by the user communicates with the receiver module to initiate the dispensing process automatically. To improve usability and inclusivity, the system generates audio prompts before dispensing, guiding users through the interaction process. In addition, the integration of GSM communication enables the system to transmit alerts and operational updates to caregivers or family members, enhancing monitoring and safety. System performance is evaluated in terms of authentication reliability, response time, and signal detection accuracy. Experimental observations indicate that the integration of RFID verification, wireless communication, and assistive voice interaction significantly enhances operational efficiency and accessibility compared to traditional manual or timer-based food dispensing methods. The proposed solution demonstrates how combining security mechanisms, assistive technologies, and communication networks can lead to the development of intelligent and inclusive automation systems. The design is suitable for applications in smart homes, healthcare facilities, and assisted living environments, where convenience, security, and accessibility are essential requirements.

Keywords

Smart Automation, Food Dispensing System, RFID Authentication, Assistive Technology, Visually Impaired Support, Embedded Systems, Voice Feedback System, GSM Communication, Smart Home Applications.

Introduction

Recent advancements in smart automation and embedded technologies have significantly transformed the way daily activities are performed in modern environments. Automation systems are increasingly used in areas such as smart homes, healthcare, and assistive technologies to improve efficiency, convenience, and safety. However, many traditional systems still rely on manual operation, lack proper monitoring mechanisms, and do not adequately support individuals with physical disabilities, particularly visually impaired users. To overcome these challenges, intelligent systems that integrate embedded controllers, wireless communication, and authentication technologies are being widely developed. These systems not only automate routine processes but also improve accessibility and security in real-world applications. The system is designed with dual operational modes to support different categories of users. For regular

users, RFID cards are used for authentication, ensuring that only authorized individuals can access the dispensing mechanism. For visually impaired users, an assistive mode is implemented using a wireless transmitter–receiver communication system that allows the user to activate the dispenser without requiring direct physical interaction. To enhance usability, the system provides voice prompts before dispensing, informing users about the current operation and guiding them through the process. Additionally, the integration of GSM communication allows the system to send notifications or alerts to caregivers or family members, thereby improving monitoring and safety. By combining authentication, assistive communication, and real-time monitoring features, the proposed system offers a reliable and inclusive automated food dispensing solution suitable for smart homes, healthcare environments, and assisted living facilities.

Literature Survey

Several studies have explored the development of automated food dispensing and smart control systems using embedded technologies. Many early systems relied on timer-based mechanisms, where food is dispensed at predetermined intervals without user interaction. Although such systems offer basic automation, they lack security, flexibility, and real-time monitoring capabilities. Recent research has focused on the use of microcontrollers, sensors, and communication modules to improve the efficiency and reliability of automated systems. RFID technology has been widely adopted in various applications to provide secure authentication and controlled access, making it suitable for automated dispensing systems. Wireless communication technologies such as RF modules have also been utilized in assistive systems to enable remote interaction, particularly for individuals with disabilities. Similarly, GSM-based communication systems have been implemented in many smart applications to provide real-time notifications and remote monitoring capabilities. Despite these advancements, most existing systems focus on individual functionalities, such as automation, authentication, or communication. Only a limited number of systems combine these technologies into a unified platform. Furthermore, accessibility features for visually impaired users are often overlooked in many existing designs. To address these limitations, the proposed system integrates RFID authentication, wireless assistive communication, GSM-based alerts, and voice feedback mechanisms within a single embedded platform. This integrated approach enhances system efficiency, improves accessibility, and provides a more inclusive solution suitable for modern smart environments.

RFID-Based Voice-Controlled Food Dispensing System

Automated food dispensing systems are becoming an important part of modern smart environments because they improve convenience, operational

efficiency, and accessibility. With the growing adoption of automation in smart homes, healthcare facilities, and assisted living environments, there is an increasing need for intelligent systems capable of performing tasks with minimal human intervention. Traditional food dispensing methods often depend on manual operation and lack essential features such as user authentication, monitoring capability, and accessibility support. These limitations can lead to security concerns, inefficient operation, and difficulties for individuals with physical disabilities. To address these challenges, embedded technologies integrated with authentication and communication mechanisms provide a practical solution. The proposed system introduces an **RFID-based voice-controlled food dispensing system** that combines identification technology with automated control. RFID authentication enables the system to recognize authorized users and restrict access to the dispensing mechanism. At the same time, a voice feedback module provides audio notifications that improve user interaction and accessibility. The system operates using a microcontroller that coordinates the interaction between different hardware components. When an RFID card is scanned, the reader transmits the card identification data to the controller. The controller verifies the received information with stored authorized records and determines whether access should be granted. Once authentication is successful, the system activates the dispensing unit through a servo motor. The voice module simultaneously provides an audible message informing the user about the ongoing process. The overall performance of the system is evaluated based on factors such as **RFID detection accuracy, response time, and operational reliability**. Although RFID technology offers secure and efficient identification, certain practical limitations may occur, including signal detection errors or dependency on proper hardware functioning. These aspects emphasize the need for improved system design and advanced assistive mechanisms, which are further discussed in subsequent chapters.

RFID-Based Communication Model

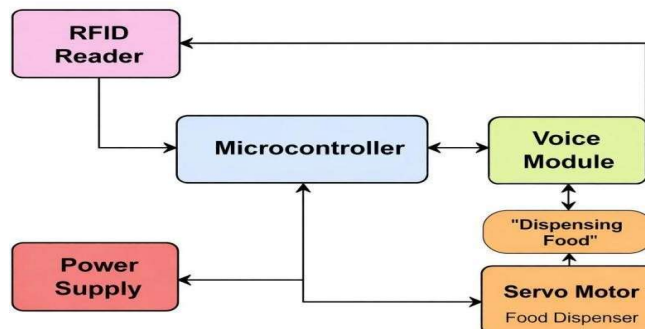


Fig 1; Block Diagram of RFID-Based Communication Model

The RFID-based communication model forms the core of the automated food dispensing system. The system integrates several hardware modules including an **RFID reader, microcontroller unit, servo motor actuator, voice feedback module, and power supply unit**. These components operate together to ensure secure authentication and controlled food dispensing. In this model, the RFID reader continuously scans for nearby RFID tags or cards. When a user presents an RFID card, the reader captures the unique identification number embedded in the card and transmits this information to the microcontroller. The microcontroller then compares the received identification number with previously stored authorized IDs. If the authentication process is successful, the controller activates the servo motor to release the required quantity of food. Simultaneously, the voice module produces an audio message to inform the user that the dispensing operation has started. This communication model ensures a simple and efficient mechanism for managing user authentication and automated system control. The architecture is suitable for deployment in environments such as residential buildings, hostels, and healthcare facilities where controlled food distribution is required. However, the effectiveness of the system depends on the correct functioning of the RFID detection process and proper coordination among hardware components. The operation of the RFID-based communication model typically involves several sequential stages. Initially, the system is initialized by configuring essential parameters such as authorized RFID identities, servo motor positions, and voice output settings. During normal operation, the RFID reader continuously monitors the surrounding area for available cards. Once a card is detected, the identification data is forwarded to the microcontroller for verification. If the card corresponds to a valid user record, the controller initiates the dispensing process by activating the servo motor mechanism. At the same time, the voice

module produces an audible notification indicating that the food dispensing action is being executed.

Assistive Voice-Based Food Dispensing System with Wireless Communication and GSM Integration

The RFID-based food dispensing system discussed in the previous chapter provides controlled access and automated dispensing through user authentication. While this approach ensures security and reduces unauthorized access, it still requires users to physically interact with the RFID reader. Such interaction can be difficult for visually impaired individuals and may limit the system’s usability in assistive environments. In addition, the basic RFID model lacks real-time monitoring features that allow caretakers or family members to observe system activity. To address these limitations, this chapter presents an enhanced **assistive food dispensing system** that integrates wireless communication, GSM technology, and voice feedback mechanisms. The proposed system enables visually impaired users to activate the food dispensing process through a wireless transmitter device without requiring direct contact with the system. When the transmitter button is pressed, the RF signal is received by the receiver module connected to the microcontroller, which then triggers the dispensing mechanism automatically. The system supports two modes of operation. The first mode is intended for normal users and operates through RFID authentication to ensure secure access. The second mode provides assistive functionality for visually impaired users through wireless communication. In addition to these features, a GSM module is incorporated to transmit notifications to caregivers or family members after the dispensing process is completed. Voice feedback is also integrated to provide audio instructions, improving user interaction and accessibility.

Assistive Communication Model

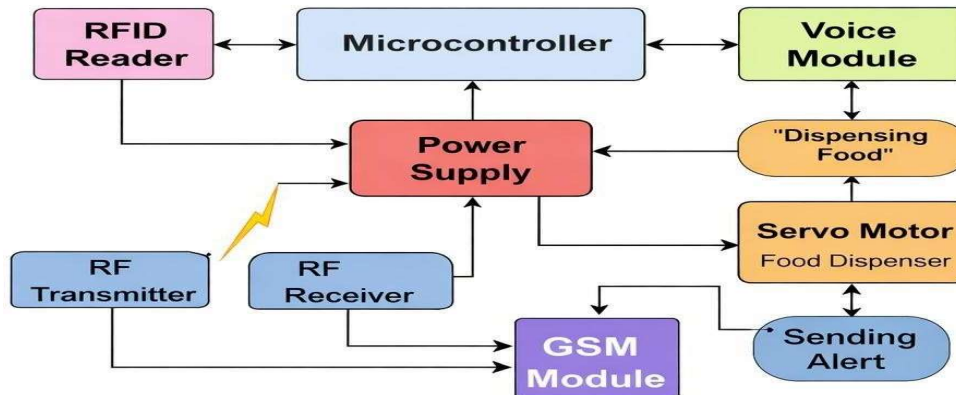


Fig 2 ;Block Diagram of Assistive Food Dispensing System

The assistive communication model represents an improved architecture that expands the functionality of the RFID-based system described in the previous chapter. The enhanced system integrates several hardware components, including an RF transmitter, RF receiver, RFID reader, GSM module, voice output module, servo motor actuator, and microcontroller unit. The RF transmitter is carried by visually impaired users and allows them to send a wireless signal to the system. The RF receiver detects the transmitted signal and forwards it to the microcontroller for processing. Once the signal is verified, the microcontroller activates the dispensing mechanism and provides audio feedback through the voice module. In addition to wireless assistive operation, the system continues to support RFID authentication for regular users. When a valid RFID card is scanned, the system verifies the user identity and activates the dispensing mechanism in the same way as the basic system. However, the addition of wireless communication and GSM modules improves both accessibility and monitoring capabilities.

During system operation, the microcontroller serves as the central processing unit that coordinates all modules. The RFID reader performs user authentication, the RF receiver processes wireless commands from visually impaired users, and the GSM module transmits notifications to designated contacts after the dispensing process. The voice module provides audible instructions that inform users about system actions. The operational sequence begins with system initialization, where parameters such as RFID card IDs, RF signal frequency, GSM communication settings, and servo motor configurations are defined. The system continuously monitors both RFID and RF signals. If a valid RFID card is detected, authentication is performed before dispensing. If a wireless signal is received from the RF transmitter, the system immediately activates the dispensing mechanism. After food is dispensed, the GSM module sends a notification message to caregivers or family members. Performance evaluation is then carried out based on response time, detection accuracy, and reliability.

System Implementation

The implementation of the proposed voice-based food dispensing system with RFID authentication and assistive technology is carried out using an embedded system platform based on the Arduino microcontroller. The system is developed and programmed using the Arduino Integrated Development Environment (IDE), which enables efficient control and coordination of multiple hardware modules. This chapter describes the hardware components used in the system and explains how they are integrated to perform automated food dispensing. The implementation focuses on the interaction between different modules such as RFID authentication, RF communication for

assistive control, GSM communication, voice feedback generation, and motor-driven food dispensing. The proposed system is designed to overcome the limitations of conventional manual food dispensing mechanisms. Traditional systems require physical interaction and manual supervision, which may not be suitable for users with visual impairments. By integrating wireless communication, automated control, and voice guidance, the system improves accessibility, operational efficiency, and remote monitoring capability.

The embedded software implemented in the Arduino microcontroller manages several core functions including RFID card detection, wireless signal processing, servo motor control, and GSM-based notification transmission. These operations are executed in a structured sequence consisting of system initialization, input detection, signal processing, and output activation.

Proper interfacing between hardware modules ensures reliable system operation under different conditions. The implementation framework also enables testing of multiple scenarios such as RFID verification, RF signal triggering, automated food dispensing, and communication with caregivers through GSM alerts.

Arduino Microcontroller

The **Arduino Uno** microcontroller serves as the central processing unit of the proposed system.

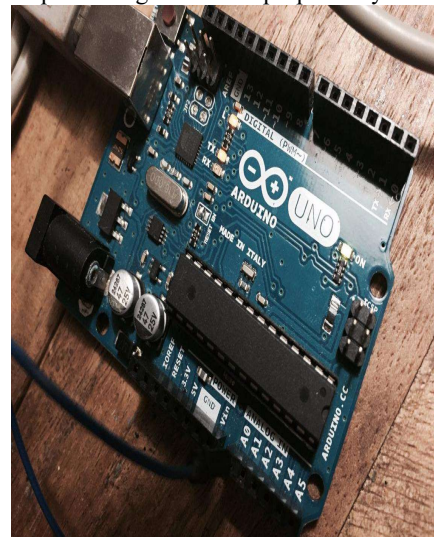


Fig 3: Arduino Microcontroller

The Arduino Uno is responsible for processing input signals received from various modules and controlling the output devices connected to the system. It reads data from the **RFID reader and RF receiver**, processes the input according to the programmed logic, and activates the required components such as the **servo motor, LCD display, GSM module, and voice module**.

Key features of the Arduino Uno include:

- ATmega328P microcontroller
- Multiple digital and analog input/output pins
- Built-in serial communication support
- Easy programming using Arduino IDE

Due to its simplicity, reliability, and wide community support, Arduino Uno is widely used in embedded system applications.

RFID Module

The **RFID (Radio Frequency Identification) module** is used for user authentication in the system.



Fig 4;RFID Module

RFID technology enables identification of objects or users using radio frequency signals without physical contact. When an RFID card or tag is placed near the reader, the module reads the unique identification number stored in the tag.

Components

- RFID Reader (MFRC522)
- RFID Cards or Tags

Working Principle

1. The RFID reader detects the presence of an RFID tag.
2. The unique identification number stored in the tag is read.
3. The data is transmitted to the Arduino microcontroller.

RF Transmitter and Receiver

The **RF transmitter and receiver module** provides an assistive interface for visually impaired users.

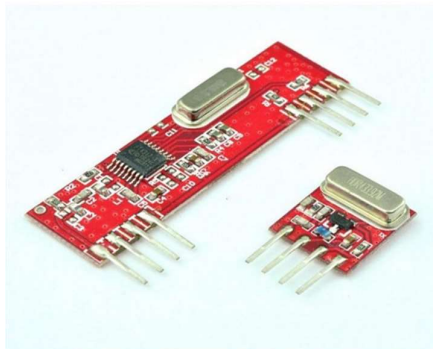


Fig:5;RF Transmitter and Receiver

This wireless communication module enables remote triggering of the food dispensing mechanism. Instead of interacting with the system directly, visually impaired users can activate dispensing using a simple RF transmitter.

Working Principle

1. The user presses a button on the RF transmitter.
2. A wireless signal is transmitted to the receiver.
3. The RF receiver detects the signal.

GSM Module

The **GSM module** is used to provide remote communication and alert functionality.



Fig 6;GSM Module

In this system, the **SIM800L GSM module** is used to send notification messages after the food dispensing process is completed.

Functions

- Sends SMS alerts
- Enables remote monitoring
- Provides communication with caregivers

Working Principle

After successful food dispensing, the Arduino microcontroller sends a command to the GSM module. The module then transmits a notification message to a predefined phone number, informing the caretaker that food has been dispensed.

Voice Module

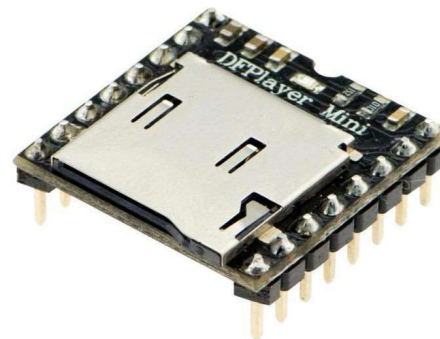


Fig 7; Voice Module

Functions

- Plays audio instructions
- Provides system status messages

- Improves accessibility for visually impaired users
- Servo Motor**
The **servo motor** is responsible for controlling the food dispensing mechanism.



Fig 8; Servo Motor

In this system, an **SG90 servo motor** is used to rotate the dispensing mechanism.

Working Principle

- The servo motor rotates to a predefined angle.
- This movement opens the food container outlet.
- After dispensing, the motor returns to its original position.

Results and Discussion

The proposed voice-based food dispensing system with RFID authentication and assistive technology was implemented and tested using the Arduino development environment to evaluate its performance under real-time operating conditions. The system performance was assessed using several important parameters including response time, operational accuracy, and system reliability for both standard users and visually impaired users.

Conventional food dispensing systems generally rely on manual operation, which can lead to inefficiencies, accessibility challenges, and lack of monitoring. In contrast, the proposed system integrates multiple technologies such as RFID-based authentication, wireless communication, GSM notification services, and voice feedback mechanisms. These integrated features provide secure access control, automated dispensing functionality, and real-time communication with caregivers or family members. The incorporation of voice feedback and wireless interaction significantly enhances usability for visually impaired individuals by allowing them to interact with the system without relying on visual interfaces or physical buttons. This makes the system more inclusive and accessible. The experimental results obtained from the prototype implementation were compared with traditional manual food dispensing methods. The comparison highlights the advantages of the proposed approach in terms of automation, efficiency, accuracy, and user accessibility.

Conclusion

The development of intelligent automation systems has created new opportunities for improving accessibility, security, and efficiency in everyday applications. This research presented the design and implementation of a voice-based food dispensing system that integrates RFID authentication, wireless assistive communication, GSM notification capability, and audio feedback mechanisms. The combination of these technologies provides an efficient and inclusive solution for automated food distribution. Unlike traditional manual dispensing methods, the proposed system enables controlled access and automated operation through embedded technology. RFID authentication ensures that only authorized users can access the system, thereby improving security and preventing misuse. In addition, the use of wireless RF communication allows visually impaired individuals to activate the system without requiring direct physical interaction, significantly improving accessibility. The system was implemented using an embedded platform programmed through Arduino IDE, enabling effective integration of multiple hardware modules. Experimental evaluation indicates that the proposed system demonstrates improved response time, detection accuracy, and operational reliability under real-time conditions. These results confirm that combining authentication mechanisms, wireless communication, and assistive technologies can effectively overcome the limitations of conventional food dispensing systems. Another important feature of the system is the inclusion of GSM communication, which allows the device to send notifications to caregivers or family members after the dispensing process is completed. This feature enhances monitoring capabilities and improves safety in environments where supervision is required. Furthermore, the integration of a voice module provides audible feedback that assists users in understanding system operations and enhances the overall user experience. The performance comparison with traditional manual systems demonstrates that the proposed automated solution offers greater efficiency, improved accessibility, and enhanced reliability. The results also indicate that the system can support different categories of users, including visually impaired individuals, thereby promoting inclusivity in smart automation applications.

Future Scope

Although the proposed system provides an effective solution for automated food dispensing, several enhancements can be explored in future research to further improve system capabilities and functionality. One possible extension involves the integration of Internet of Things (IoT) technology. By connecting the system to cloud-based platforms, remote monitoring and control can be enabled through mobile or web applications. This would

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allow users and caregivers to observe system activity and manage food dispensing operations from any location. Another promising improvement is the implementation of advanced voice recognition techniques. Instead of relying solely on predefined audio prompts, natural speech recognition systems could allow users to interact with the device using voice commands. Such functionality would significantly enhance user interaction and accessibility. Security can also be strengthened by incorporating biometric authentication methods, such as fingerprint scanning or facial recognition, either as a replacement for or an enhancement to RFID technology. Biometric authentication would provide stronger identity verification and reduce the possibility of unauthorized system access. Future developments could also include the creation of a mobile application interface that allows users to monitor system status, receive notifications, and configure system parameters remotely. Such an application would improve usability and provide greater flexibility in managing the system.

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