BILLING SYSTEM USING RF ID

A PROJECT WORK REPORT

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ABSTRACT

In modern pharmacy operations, manual billing systems are often slow, error-prone, and inefficient, especially during peak hours. This project presents a Smart Billing System for Medical Shops using RFID technology, implemented with an ESP32 microcontroller, MFRC522 RFID reader, LCD display, and a 4x4 matrix keypad. The aim is to simplify and automate the process of billing tablets by scanning RFID tags, reducing human effort and ensuring high accuracy in transaction handling. In this system, every tablet strip is associated with a unique RFID tag that contains key details such as the medicine name and unit price. When a tag is brought near the RFID reader, the ESP32 identifies the unique UID, compares it with pre-stored tag data, and fetches the corresponding tablet information. The LCD displays the name and price of the medicine. The pharmacist or user can then input the required quantity using the keypad, and the system will automatically calculate and display the total amount to be billed. Compared to traditional methods where each item is manually looked up and entered into billing software, this system improves billing speed, reduces human error, and provides a clean user interface with real-time LCD feedback.

The RFID integration eliminates the need for barcodes or manual inventory searches. From a technical standpoint, the system uses structured data arrays to store tablet details, with efficient UID matching algorithms to identify RFID tags. The keypad interface supports multi-digit quantity input with real-time feedback and error correction. The ESP32 handles all logic processing and is easily programmable, making the system scalable and adaptable. Furthermore, the ESP32's built-in Wi-Fi capability opens up future scope for cloud-based inventory management, online sales tracking, automated restocking notifications, and real-time transaction monitoring. By integrating with a backend database or mobile app, the system can be expanded to maintain digital records, monitor expiry dates, and even analyze sales trends. This solution not only enhances customer service by reducing waiting time but also empowers pharmacists with a smart and automated way of managing daily operations. The project demonstrates how embedded systems and RFID technology can be integrated to form a reliable, low-cost, and scalable smart billing solution for medical shops and other retail domains.

CHAPTER 1

INTRODUCTION

Pharmacies and medical shops are crucial points of contact for patients and healthcare consumers, and therefore must handle their operations with high levels of precision and speed. However, the traditional billing systems used in most small to medium-sized medical shops are still manual or semi-automated, leading to significant challenges such as billing errors, long customer wait times, inefficient stock management, and difficulty in scaling operations.

Traditional billing typically involves manually identifying medicines, entering their prices into a billing system or ledger, and then calculating the total cost. This process is not only time-consuming but also prone to human errors, especially during rush hours. Additionally, stock updates are usually done manually at the end of the day, making it difficult to keep real-time track of inventory. These inefficiencies highlight the need for a modern, smart solution that can improve accuracy, speed, and ease of management.

The pharmacist can then enter the desired quantity using the keypad, after which the system calculates the total amount and displays it. This eliminates manual data entry, reduces errors, and improves transaction speed. Furthermore, the system can be programmed to update the stock after every transaction, thus maintaining a live inventory count. This approach not only simplifies billing but also supports efficient inventory management.

1.1 EXISTING CHALLENGES IN MEDICAL SHOP BILLING

Pharmacies and medical shops are critical points of contact for healthcare consumers and patients, where quick, precise, and error-free service is essential. Unfortunately, many small to medium-sized medical shops still rely on traditional, manual, or semi-automated billing systems. These systems require pharmacists to manually identify medicines, input their prices into a ledger or billing software, and compute the total cost. This process is slow and prone to human errors, especially during peak business hours when there’s a rush of customers. Moreover, inventory updates are typically performed at the end of the day, making it difficult

to keep an accurate, real-time track of stock levels. These challenges highlight the need for an advanced, automated billing solution that can improve accuracy, reduce customer wait times, and streamline inventory management.

1.2 PROPOSED SMART BILLING SOLUTION

To address these limitations, this project proposes a Smart Billing System for Medical Shops using RFID technology, an ESP32 microcontroller, an MFRC522 RFID reader, a 4x4 matrix keypad, and a 16x2 LCD display. In this system, every medicine strip is tagged with a unique RFID card containing essential data such as the medicine name and unit price. When the RFID tag is scanned, the system instantly identifies the medicine and displays its details on the LCD screen. The pharmacist can then input the required quantity using the keypad, and the system automatically calculates and displays the total bill amount. This eliminates the need for manual item selection and price entry, reducing the chances of billing errors and speeding up the overall transaction process.

1.3 BENEFITS OF THE PROPOSED SYSTEM

The proposed smart billing system offers several practical benefits. By minimizing human intervention in the billing process, it ensures improved transaction accuracy and reduces the risk of errors. Faster billing enhances customer service, particularly during busy hours. The system also features a simple and user-friendly interface comprising an LCD display and a 4x4 matrix keypad, making it easy to operate for pharmacy staff. Being built around the ESP32 microcontroller, the system remains cost-effective, compact, and scalable — suitable for both small and large medical shops. Moreover, it demonstrates how embedded systems and RFID technology can be applied to modernize retail operations.

1.4 FUTURE SCOPE AND ENHANCEMENTS

Looking ahead, this system provides scope for various future enhancements. By utilizing the built-in Wi-Fi capability of the ESP32, the system can be connected to cloud-based databases, enabling real-time inventory monitoring and transaction logging across multiple branches of a pharmacy chain. Mobile app integration can allow pharmacists or shop owners to remotely track stock levels, sales data, and expiry alerts. Additionally, sales analytics tools can be incorporated to identify fast-moving products, peak business hours, and sales trends, assisting in better inventory planning and customer service. These future possibilities make the proposed smart billing system not only a practical current solution but also a solid foundation for more advanced pharmacy management systems.

1.5 IMPORTANCE OF REAL-TIME TRANSACTION FEEDBACK

In any customer-facing business, especially in pharmacies where accuracy and speed are critical, providing real-time transaction feedback is essential for maintaining customer trust and operational efficiency. In traditional billing methods, delays in confirming medicine names, prices, and total amounts often lead to confusion, misbilling, and customer dissatisfaction. The proposed RFID-based Smart Billing System addresses this by offering instant, step-by-step feedback on a dedicated LCD screen.

As soon as an RFID tag is scanned, the medicine name and price are displayed immediately, followed by real-time updates when the pharmacist enters the quantity. The system then calculates and presents the total price instantly. This ensures that both the pharmacist and the customer remain informed at every stage of the transaction. Real-time feedback not only helps reduce mistakes but also enhances customer confidence in the service, as they can see their purchase details being processed live.

Additionally, clear transaction feedback reduces the cognitive load on the pharmacist, allowing them to focus on customer service rather than manual calculations. This real-time interaction ensures smoother, faster, and error-free billing, which is especially beneficial during busy hours or emergencies.

CHAPTER 2

LITERATURE SURVEY

In recent years, the integration of embedded systems and RFID (Radio Frequency Identification) technology has seen a significant rise in retail and pharmacy automation applications. Numerous studies and projects have focused on developing smart billing systems to overcome the limitations of conventional manual billing processes. This literature survey summarizes existing works and technological advancements relevant to this project.

The increasing demand for automation in retail and healthcare sectors has driven the development of smart billing and inventory management systems. Several research works and technological advancements have explored the integration of RFID technology, microcontrollers, and embedded systems to improve operational efficiency in billing and inventory management. This literature survey highlights key studies and related work relevant to the proposed smart billing system for medical shops.

2.1 RFID-BASED BILLING SYSTEMS

Several researchers have explored RFID-based smart billing systems as a replacement for traditional barcodes. According to S. Sharma et al. (2017), RFID systems offer superior operational speed and data accuracy compared to barcode scanning, particularly in busy retail environments. RFID tags, being contactless and capable of storing more data, reduce transaction time and minimize human errors associated with manual billing.

Another study by D. Gupta et al. (2019) introduced a prototype RFID-based billing cart that automatically detects products placed in a shopping cart and computes the total bill in real-time, streamlining checkout procedures in supermarkets. This system emphasized RFID's potential in point-of-sale (POS) automation but was more focused on general retail rather than pharmacy-specific applications.

2.2 RFID APPLICATIONS IN PHARMACY MANAGEMENT

Pharmacy operations require strict control over inventory, expiry dates, and transaction records. A study by M. Rajasekar et al. (2020) proposed an RFID-based medicine management system for hospital pharmacies. It enabled real-time tracking of medicine availability and automatic detection of expired drugs, reducing the risk of dispensing outdated medicines.

Though such systems focused primarily on inventory management, the integration of RFID for direct billing processes within medical shops remains less explored, creating a niche opportunity for systems like the one proposed in this project.

2.3 EMBEDDED SYSTEMS FOR AUTOMATED BILLING

Embedded controllers like Arduino and ESP32 are widely used for implementing real-time control systems due to their cost-effectiveness, flexibility, and ease of programming. K. Singh et al. (2018) presented an Arduino-based automatic billing system for grocery stores, combining barcode scanners and digital displays. While effective, barcode systems have limitations such as line-of-sight requirements and lower data capacity compared to RFID.

ESP32, in particular, offers enhanced processing capabilities and built-in Wi-Fi, enabling future cloud-based enhancements. P. Kumar et al. (2021) highlighted ESP32's suitability in IoT-based retail solutions due to its multi-interface support, low power consumption, and scalability in connecting peripheral devices like RFID readers, LCDs, and keypads.

2.4 KEYPAD-BASED QUANTITY INPUT SYSTEMS

In transaction systems, numeric keypads are often used for quantity or PIN input. A. Roy et al. (2019) demonstrated a digital locker system with an ESP8266 and 4x4 matrix keypad for PIN entry and access control, emphasizing the reliability of keypad interfaces for secure, real-time data entry in embedded applications. Incorporating similar input mechanisms into billing systems ensures ease of use and efficient transaction handling.

CHAPTER 3

EXISTING METHOD

In most medical shops and pharmacies, the billing process is carried out either manually or with the help of basic point-of-sale (POS) software. The pharmacist or billing staff typically identifies each medicine by visually checking its name on the packaging and then looking up its price either on the medicine strip or in the software database. Once identified, the medicine name and its price are manually entered into the billing system. The required quantity is also input by hand, after which the system computes the total bill for the customer. In a few modern medical shops, barcode scanners are used to speed up the process, but this depends on whether the medicine packaging has a barcode — which is often missing, damaged, or difficult to read on many medicine strips and loose tablets, especially in smaller retail pharmacies.

This method, though widely used, is time-consuming and prone to several types of human errors. Common issues include entering incorrect medicine names, wrong prices, or selecting the wrong item from the software's list. Errors in quantity input can also occur, leading to misbilling. These mistakes become especially frequent during peak hours when pharmacies deal with a higher volume of customers and staff may experience fatigue or pressure to work faster. As a result, customer waiting times increase, and transaction accuracy is compromised.

Additionally, inventory management in most medical shops is also handled manually. Stock levels are typically updated at the end of the day or week by manually counting remaining stock and entering quantities into a register or software. This makes it difficult to track real-time stock availability, increasing the risk of stockouts for essential medicines or expiry date oversight. This lack of real-time stock updates further complicates inventory control, causing inefficient restocking practices and possible customer dissatisfaction when medicines are out of stock.

3.1LIMITATIONS AND CHALLENGES

- The traditional method relies on the pharmacist manually entering medicine names, prices, and quantities, which often leads to errors in billing due to mistyped data or incorrect item selection.

- During peak hours, manually searching for medicines and entering data slows down the billing process, increasing wait times for customers and reducing overall efficiency.

- Price changes must be updated manually in the billing software or noted separately. This can lead to inconsistent or outdated pricing being applied during transactions.

- The absence of immediate visual confirmation for each entry can make it difficult to catch mistakes in real time, leading to billing discrepancies.

- Traditional systems often lack sales history tracking, making it difficult to generate accurate reports or analyze customer buying patterns.

- The entire process depends heavily on the attentiveness and experience of the operator, making it vulnerable to fatigue, stress, and human oversight.

- Inventory is usually updated manually at the end of the day or week, leading to stock mismatches, expired medicines going unnoticed, and poor restocking decisions.

- Manual systems make it difficult to continuously monitor medicine expiry dates, increasing the risk of expired medicines being dispensed or going unnoticed on shelves.

- Traditional systems don’t easily support customer relationship features like sending SMS notifications for prescription refills, order-ready alerts, or digital receipts.

- Applying promotional offers, discounts for bulk purchases, or loyalty points manually increases the risk of errors and inconsistencies, and often slows down the transaction process.

CHAPTER 4

PROPOSED METHOD

The proposed method involves the development of Billing System Using RF Id Reader Figure 4.1, RF Id Card Figure 4.2, ESP32 Figure 4.3, LCD Figure 4.4, Keypad Figure 4.5.

Figure 4.1 RF ID READER

Figure 4.2 RF ID SMART CARD

One of the key advantages of the RFID-based Smart Billing System for Medical Shops is its compact and portable design. The entire hardware setup including the ESP32 microcontroller, RFID reader, LCD display, and keypad consists of lightweight components, making it easy to assemble and carry. This makes the project ideal for demonstration purposes, exhibitions, and academic presentations. The system can be conveniently mounted on a cardboard base, which serves as a cost-effective and practical platform for showcasing the working model. Cardboard provides sufficient support for holding the electronic modules, and the components can be attached using glue, tape, or small fasteners without the need for specialized tools.

Figure 4.3 ESP32

As Shown in Figure 4.3, The ESP32 is programmed to handle all logical operations, such as UID matching, price calculation, and user input processing. Due to its low power consumption and high reliability, the ESP32 is well-suited for real-time applications in a pharmacy setting.

Additionally, its built-in Wi-Fi offers future scalability for cloud-based inventory updates, remote monitoring, or integration with online billing systems. When an RFID tag is scanned, the ESP32 reads the tag's UID, compares it with pre-stored data, retrieves the corresponding medicine information, and displays it on the LCD. It then waits for quantity input from the keypad, calculates the total cost, and outputs the final bill on the display.

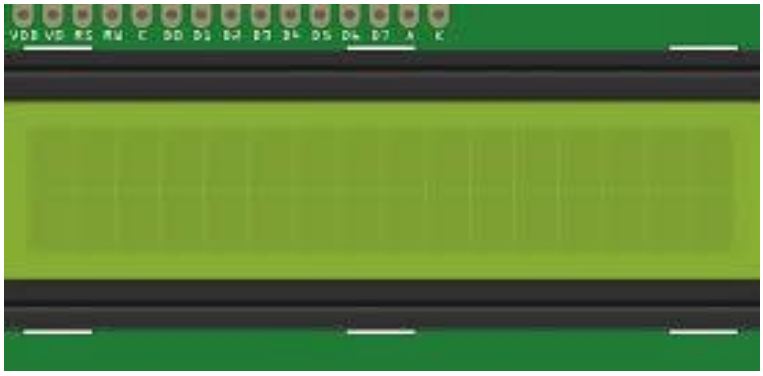

Figure 4.4 LCD

In the proposed RFID-based Smart Billing System for medical shops, the Liquid Crystal Display (LCD) serves as the primary output interface for the user. A 16x2 I2C LCD is used for its compact size, low power consumption, and ease of integration with the ESP32 microcontroller. As shown in Figure 4.4 the LCD is positioned prominently in the setup to ensure clear visibility for the pharmacist or user.

FIGURE 4.5 KEYPAD

In the proposed RFID-based Smart Billing System, the 4x4 matrix keypad functions as the primary input device for the user. It is used to enter the quantity of the medicine after scanning the RFID tag. As shown in Figure 4.5, the keypad is integrated into the system in a user-friendly position, allowing pharmacists to quickly input the number of units needed.

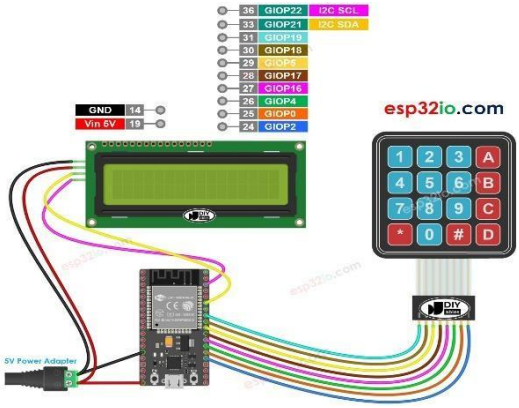

Figure 4.6 INTERFACE OF LCD AND KEYPAD

When a valid RFID tag is scanned, the ESP32 prompts the user via the LCD to enter the desired quantity using the keypad. The LCD, connected via the I2C protocol, requires only two pins (SDA and SCL), significantly reducing the wiring complexity and GPIO usage. Once the user enters the quantity using the keypad, the ESP32 reads this input, performs the required calculations (such as total cost), and then displays the final billing information on the LCD. This seamless interaction between the keypad, LCD, and ESP32 ensures a smooth and responsive user experience, while maintaining a clean and efficient hardware setup suitable for portable or demonstration environments.

4.1 METHODOLOGY AND WORKING

Design and Fabrication of Billing System: The design and fabrication stage involved selecting the core components required to implement the RFID-based smart billing system. Components such as the ESP32 microcontroller, MFRC522 RFID reader, 16x2 I2C LCD, and a 4x4 matrix keypad were chosen for their compatibility, low power consumption, and ease of integration. The layout of the system was planned to keep wiring minimal and connections straightforward. A simple frame or enclosure was created using cardboard to mount and hold all components, making the project easy to carry and present. This phase emphasized a compact and organized design, suitable for prototyping and demonstration in academic or small pharmacy settings.

Integration of Billing System Components: In the integration phase, the selected components were connected together in a cohesive system. The RFID reader was wired to the SPI pins of the ESP32, while the LCD was interfaced using the I2C protocol to reduce pin usage. The keypad was connected through eight digital GPIO pins and configured for scanning key presses. The ESP32 served as the central control unit, coordinating inputs from the RFID and keypad, and driving outputs to the LCD.

Integration and Testing: After physical integration, thorough testing was conducted to verify the working of individual modules and the system as a whole. The RFID module was tested for accurate detection of tag UIDs, and the keypad was checked for correct key mapping and input reliability. The LCD display was validated to ensure it displayed the medicine name, unit price, and total cost clearly. Then, all components were tested together in the billing flow from scanning the RFID tag, entering quantity, to displaying the total cost. Issues like keypad debounce, display delays, and occasional tag reading errors were identified and resolved during this phase to ensure smooth operation.

Operation: The operation of the system is user-friendly and efficient. When powered on, the LCD shows a welcome message indicating readiness. The user scans an RFID tag attached to a medicine strip, and the system retrieves the relevant information such as medicine name and price. This is displayed on the LCD. The pharmacist then enters the desired quantity using the keypad.

Evaluation and Optimization: The system was evaluated for performance in terms of speed, accuracy, and ease of use. It was observed that the RFID reader could quickly detect and identify tagged medicines, and the keypad provided a responsive way to enter quantities. The display of information on the LCD was clear and fast. n the optimization phase, various ideas were explored to enhance the system’s performance and usability. Suggestions included improving the display format for better readability, reducing delay in keypad input, and adding audible feedback for better user interaction.

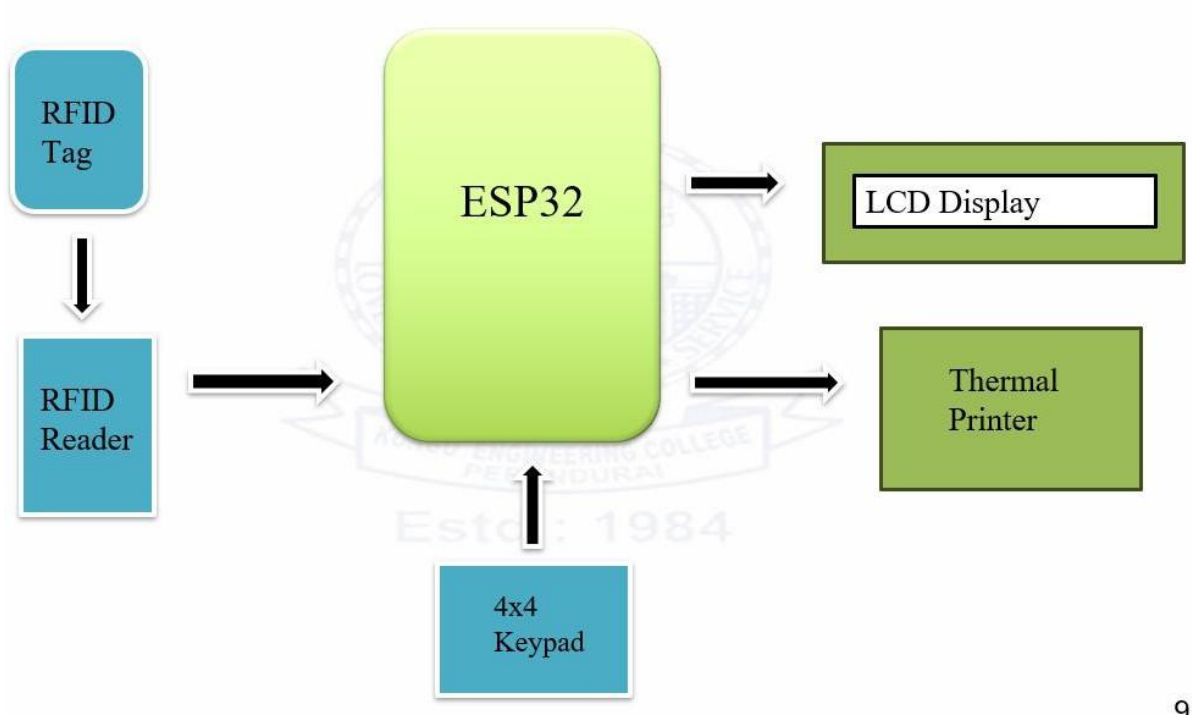

Figure 4.7 Block Diagram of the Project

The system starts with the initialization of the ESP32 microcontroller and its connected devices, including the RFID reader, LCD, and keypad. When a pharmacist scans a medicine's RFID tag, the reader captures its UID and sends it to the ESP32. The controller matches the UID with stored data to fetch the corresponding medicine name and price, which are displayed on the LCD. The pharmacist then inputs the required quantity using the keypad. The system calculates the total price by multiplying the quantity with the unit price and displays it. This process repeats for additional items, and the bill can be cleared using a reset button.

CHAPTER 5

RESULTS AND DISCUSSION

The development of the RFID-based smart billing system was carried out in a modular and systematic manner to ensure ease of implementation and testing. Initially, the ESP32 microcontroller was programmed using Arduino IDE, integrating the necessary libraries for the MFRC522 RFID module, 16x2 I2C LCD, and the 4x4 keypad.

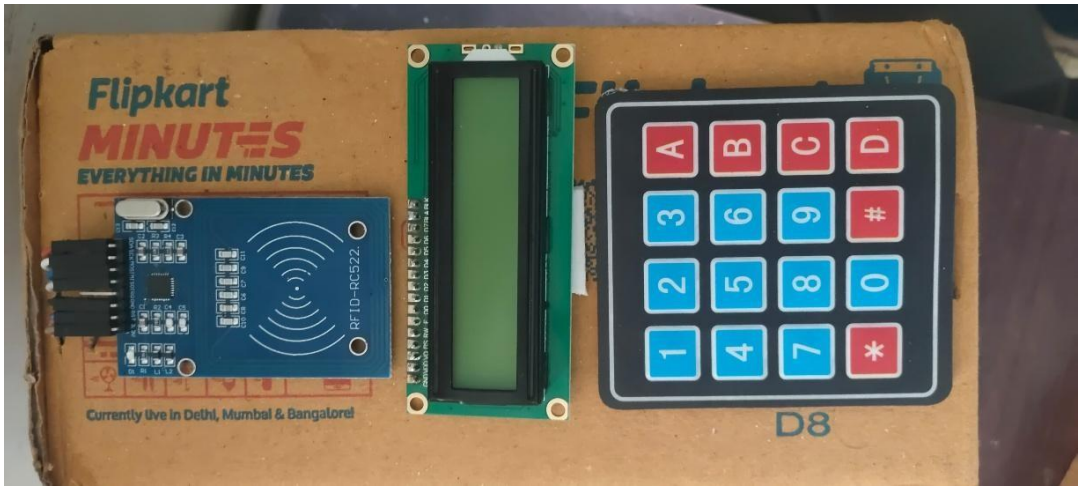

Figure 5.1 Prototype of proposed model

Efficiency and Accuracy: The proposed RFID-based smart billing system significantly enhances both efficiency and accuracy in the billing process at medical shops. By automating the identification of medicines using RFID tags, the system eliminates the need for manual item entry, which is often time-consuming and error-prone. The use of an ESP32 microcontroller ensures fast data processing, enabling quick retrieval of item information and immediate price calculation upon input of quantity.

Reliability and Durability: The system responds reliably to RFID scans without the need for repeated attempts, and the keypad offers durable mechanical switches capable of handling frequent input without failure. The LCD screen provides clear output even after extended usage, making the display readable under typical indoor lighting.

User-Friendliness: When an RFID tag is scanned, the medicine name and unit price are automatically shown on the screen, reducing the need for manual input or product searching. The pharmacist only needs to enter the quantity using the keypad and press a confirmation key to generate the total price, which is immediately displayed. The entire process is fast, requiring minimal training, and can be learned in just a few minutes.

Scalability and Adaptability: The RFID-based smart billing system is built with a modular and flexible architecture, allowing it to be easily scaled and adapted to suit the growing needs of a medical shop or even larger pharmacy chains. The current setup supports a limited number of RFID-tagged medicines stored in the microcontroller's memory.

Future Improvements: One of the most important upgrades would be the integration of a stock management feature, where the system automatically updates inventory levels after each transaction. This can be implemented using the ESP32's Wi-Fi capability to connect with a cloud-based or local database.

Figure 5.2 Working of Prototype proposed model

The output of the RFID-Based Smart Billing System is a smooth, accurate, and user-friendly billing process tailored for medical shops. When a medicine strip with an RFID tag is scanned using the MFRC522 RFID reader, the ESP32 microcontroller immediately detects the unique UID and retrieves the corresponding medicine details from its stored database. This includes the medicine's name and unit price, which are instantly displayed on the 16x2 LCD screen, providing clear and immediate confirmation for the pharmacist.

Following this, the system prompts the pharmacist to enter the desired quantity of the medicine using the 4x4 matrix keypad. As the quantity is entered, it is shown in real-time on the LCD, ensuring the user can verify and, if necessary, correct the input before finalizing the transaction. Once the quantity is confirmed, the ESP32 performs an automatic calculation of the total cost by multiplying the unit price with the entered quantity.

The calculated total is then displayed clearly on the LCD, making it easy for both the pharmacist and the customer to verify the final amount before proceeding. This automated process eliminates the need for manual price lookups, barcode scanning, or handwritten billing, significantly reducing the chances of human error. Additionally, the LCD provides step-by-step feedback throughout the process — from scanning the tag to confirming the total — guiding the pharmacist at every stage.

Figure 5.3 Output of Rf Id tag

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1CONCLUSION

The RFID-Based Smart Billing System for Medical Shops presents a practical and efficient alternative to the conventional manual billing procedures commonly used in small and medium-sized pharmacies. By seamlessly integrating essential hardware components such as the ESP32 microcontroller, MFRC522 RFID reader, 16x2 I2C LCD display, and 4x4 matrix keypad, this system successfully addresses several challenges typically faced in traditional pharmacy operations, including slow transaction speeds, human errors in billing, and operational inefficiencies.This project demonstrates how modern embedded systems and IoT-based solutions can be applied to retail management within the healthcare sector. Through RFID technology, medicines can be quickly identified and billed with minimal human intervention, ensuring accuracy in item recognition and pricing. The keypad allows for user-friendly quantity input, while the LCD provides real-time feedback, improving overall transparency and transaction clarity. The addition of a physical reset button for clearing the bill enhances system usability and ensures smooth operation for pharmacy staff.

One of the significant advantages of this system is its cost-effectiveness and ease of implementation, making it highly suitable for small to medium-scale medical shops that may not have the resources for large-scale automated solutions. The system not only accelerates the billing process but also reduces the likelihood of errors associated with manual entry, leading to improved customer service and operational efficiency. Moreover, this project sets a foundation for potential future enhancements. Features such as inventory management, digital payment integration, customer purchase history tracking, and data analytics for sales trends could be incorporated to expand the system's capabilities. The modular design of the project ensures that such improvements can be integrated without the need for significant hardware modifications. In conclusion, the RFID-Based Smart Billing System for Medical Shops stands as a reliable, scalable, and innovative approach towards modernizing retail pharmacy operations. It highlights the practical application of embedded systems and IoT technology in addressing real-world problems and improving service delivery in the healthcare retail sector.

6.2FUTURE SCOPE

The RFID-Based Smart Billing System holds significant potential for further development and real-world application. One major area of improvement is the integration of automatic stock management, where the system can deduct items from inventory as they are billed. This can be achieved by connecting the ESP32 to a cloud-based database using its built-in Wi-Fi, allowing real-time inventory tracking and remote access for store owners and managers. Another promising enhancement is the integration of a mobile application for both Android and iOS platforms. This app would enable users to monitor sales, stock levels, and transaction histories in real-time, providing added convenience and flexibility to manage store operations remotely. Additionally, implementing multi-user authentication through RFID employee cards would allow tracking of individual sales, work shifts, and responsibilities, improving accountability and workflow management within the store.

The system can also be upgraded to support online payment methods such as UPI, QR code scanning, or NFC-based digital wallets, offering customers a faster and more secure checkout experience. Furthermore, replacing the 16x2 LCD with a touchscreen display could greatly enhance the user interface, making item selection, billing, and system control more intuitive and efficient for both customers and staff. A voice assistance feature can also be introduced to provide voice-guided instructions, making the system more accessible and user-friendly, especially in busy retail environments. In addition, an automated reordering system can be implemented by setting minimum stock levels within the inventory database, enabling the system to send alerts or purchase requests to suppliers when stock runs low.

Another valuable addition would be incorporating data analytics and reporting features to generate daily, weekly, or monthly summaries on sales trends, peak business hours, popular products, and employee performance. These insights can help business owners make informed decisions to improve store operations and customer satisfaction. Lastly, enhanced security measures such as integrating camera modules and RFID-based anti-theft detection can be considered to prevent unauthorized item removal or billing bypass. For chain stores or retail franchises, multi-branch cloud synchronization can also be implemented to maintain and manage inventory and sales data across multiple locations through a centralized cloud database.