ENHANCING THE AUTOMATION OF TRADITIONAL PROCESS IN SHOPPING CART USING RFID

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ABSTRACT

The Internet of Things (IoT) is all about connecting devices like sensors and machines so they can share data without humans directly getting involved. This includes things like heart monitors and cars with sensors. By doing this, it makes processes more efficient across different industries and can change how we do things in our daily lives. For example, in retail, there's a show called IoT that's using wireless sensors and RFID technology in Smart Shopping Carts. The goal is to make shopping easier by speeding up the process, reducing wait times, and improving service quality through wireless communication and automated billing. This kind of technology isn't just for shopping; it's also about creating a system where devices can talk to each other and make things better for us in many different ways, like managing resources smarter, making better decisions using data, and making sure everything stays safe and secure. Overall, it's about using technology to make life easier and more efficient across the board, from shopping to managing resources in a sustainable way.

This integration streamlines tasks like restocking, checkout processes, and even reduces food wastage, aligning with sustainability goals The modern era of technology has brought about a significant challenge in supermarkets where customers often face long waits due to the time-consuming barcode-based billing process, especially during peak times like discount offers or weekends.. The system then wirelessly sends this data to the server for automatic billing generation, aiming to streamline the shopping process and improve service quality. This prototype can be implemented and tested commercially, making it a competitive solution in modern retail settings.. Overall, IoT transforms traditional retail processes, offering real-time updates and a smoother checkout experience, leading to a more efficient and enjoyable shopping journey.

Keywords: *IOT, RFID Technology, Shopping Cart.*

INTRODUCTION

The Internet of Things (IoT) is a network that connects various devices, including sensors, software-enabled machines, and consumer objects, allowing them to exchange data with each other and the cloud. This interconnected system enables organizations across industries to operate more efficiently, enhance customer service, make better decisions, and add value to their businesses. IoT devices are embedded with technology like sensors and software, enabling data transfer over networks without human-to-human or human-to-computer interactions. These devices can be diverse, from heart monitors in people to biochips in farm animals or built-in sensors in automobiles that monitor tire pressure. Essentially, anything with an Internet Protocol (IP) address capable of transferring data over a network can be part of the IoT. This networking of physical objects, with electronics embedded within their architecture, allows them to communicate and interact with each other or with the external environment. In the coming years, IoT technology will offer even more advanced services and significantly impact daily life. It creates a system where interconnected things, including computing devices, machines, objects, animals, or people, have unique identifiers and can transfer data over networks, all without requiring direct human involvement. This evolution in connectivity and automation has the potential to reshape how people live and work on a day-to-day basis Smart contracts (1).

IOT devices are equipped with sensors that enable them to sense their surroundings and collect data, storing it within their systems. These devices encompass a wide range of everyday appliances such as mobile phones, coffee machines, microwaves, geysers, fire alarms, air conditioners, cars, and more. The embedded sensors continuously emit data about their environment and the operational status of these devices, contributing to a wealth of information that is aggregated and processed within IoT platforms (2-3). These IoT platforms comprise cloud servers and expansive databases that act upon the collected data. They integrate and analyze the information meticulously to extract crucial insights, subsequently issuing instructions based on this analyzed data. Furthermore, the aggregated data is shared with other devices, enhancing their future performance and overall user experience. The term "Internet of Things" encapsulates the interconnected network of devices facilitated by advanced technology that enables communication between devices and the cloud, as well as inter-device communication, allowing billions of devices, ranging from commonplace objects like toothbrushes and vacuums to sophisticated machinery, to harness sensors and intelligently respond to user interactions. However, with the evolution of low-power RFID tags and miniaturization of computing devices, these chips have become smaller, faster, and more sophisticated, ushering in a new era of interconnected "things" with the internet. Managing the vast amount of data generated by IoT devices is also a significant challenge. IoT devices continuously collect and transmit data, leading to data overload if not managed properly. Efficient data management strategies, including data storage, processing, and analytics, are crucial to extract meaningful insights from this data without overwhelming systems (4).

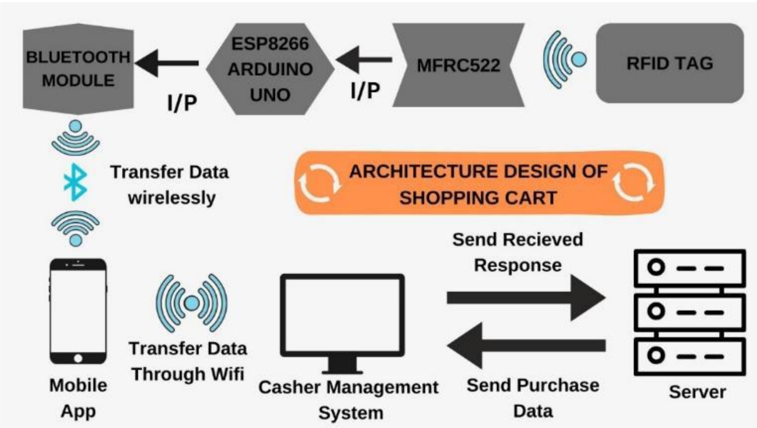
Additionally, addressing scalability concerns 2 as IoT networks expand and ensuring reliable connectivity in diverse environments are ongoing challenges that require continuous innovation and adaptation in IoT technologies. One major advantage is increased efficiency and productivity. IoT enables automation of processes, remote monitoring, and real-time data analysis, allowing businesses to streamline operations and make data-driven decisions faster (5). Additionally, IoT enhances convenience and improves quality of life by enabling smart homes, personalized healthcare, and efficient transportation systems. Overall, IoT has the potential to revolutionize industries, improve services, and create a more connection.

Implementation

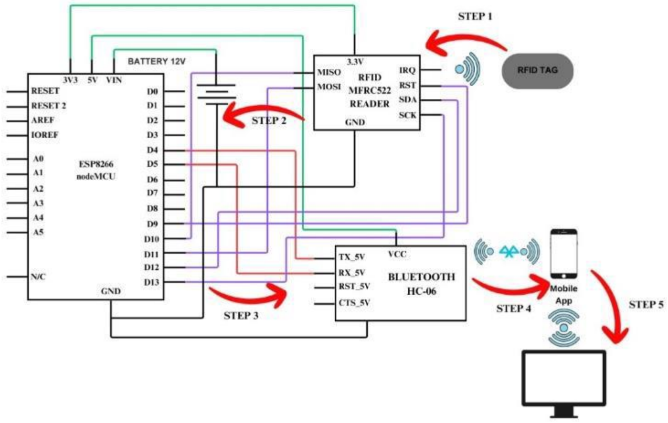
The proposed system is made up of an Implementing RFID technology in retail operations has proven to be a game-changer across various facets of the industry. By embedding RFID tags into products, retailers gain real-time insights into inventory levels, effectively curbing stock outs while preventing overstock situations. This innovation extends to the shopping experience, where automated checkout processes revolutionize the way customers interact at the point of sale. However, the benefits of RFID technology transcend mere operational enhancements. Its integration fuels customer engagement by enabling personalized recommendations and tailored promotions based on items detected in the cart. This not only fosters customer loyalty but also elevates the overall shopping experience. Security measures are bolstered by RFID's anti-theft capabilities, triggering alarms should any item be removed from the store without proper authorization or payment. Beyond this, RFID facilitates operational efficiency by automating mundane tasks such as restocking shelves, managing expiration dates, and generating real-time reports, streamlining store operations significantly. Supply chain visibility also undergoes a transformation with RFID integration, enhancing traceability from manufacturers to store shelves, effectively reducing errors and delays.

Moreover, the customer experience receives a substantial boost with features like self-checkout, automated loyalty point accumulation, and digital shopping lists, all made possible through RFID technology. The scope of RFID's impact extends beyond operations and customer experiences. Its application in environmental sustainability through more efficient waste management by tracking perishable items and minimizing food spoilage aligns retail practices with broader sustainability goals. As RFID technology continues to evolve its potential to revolutionize retail remains boundless, reshaping the industry in ways previously unimaginable. The RFID shopping cart system is designed to revolutionize the traditional shopping and checkout experience. In this innovative setup, every product within the store is affixed with an RFID tag, a small electronic device containing unique identification and pertinent details such as the product name and price. Simultaneously, each shopping cart is equipped with an RFID reader (5).

When a customer places an item into the cart, the RFID reader swiftly scans the RFID tag on the product. This initiates a wireless transmission of data, including the unique identifier and associated information, to a central microcontroller, often implemented using devices like Arduino. Acting as the brain of the system, the microcontroller processes this data, extracting essential details like the product's name and price. The microcontroller is seamlessly integrated with a billing system, establishing real-time communication. As each item is scanned, the billing system dynamically updates the total cost, offering an instantaneous and accurate reflection of the items within the cart. The interaction between the microcontroller and the billing system ensures an efficient and synchronized tracking of the shopping cart's contents. To enhance customer engagement and transparency, an LCD display is incorporated into the shopping cart. This display showcases the names and prices of the scanned items, providing shoppers with immediate feedback on their purchases. The display is continuously updated as more items are added, offering a real-time summary of the shopping session. Throughout the shopping process, the billing system diligently calculates the total cost, creating a running tally based on the scanned items. Once the customer has completed their shopping, they proceed to the checkout area. At this stage, the billing system generates a final bill that encapsulates all the scanned items and their respective costs.



The customer then proceeds to make the payment for the total amount indicated on the final bill, thus completing the transaction. This RFID-based shopping cart system significantly streamlines the entire shopping experience, introducing automation to the billing process and reducing the need for manual input. The result is a more efficient and user-friendly shopping journey for customers in the supermarket. The RFID shopping cart system transforms traditional shopping by using RFID tags on products and RFID readers on carts. When a customer adds an item, the reader scans its RFID tag, sending data to a central microcontroller like Arduino. This microcontroller processes details like product names and prices and communicates with the billing system, updating the total cost in real-time. An LCD display on the cart shows scanned items and prices, keeping shoppers informed. At checkout, the system generates a final bill for payment, automating billing and enhancing the shopping experience with efficiency and transparency. Integrating RFID sensors into shopping carts alongside a dedicated mobile app presents a groundbreaking concept in modern retail. This system aims to empower consumers by simplifying their shopping experience through RFID technology. It assists customers in finding products that match their preferences and quality standards effortlessly.



Circuit Diagram

A shopping system that's like a high-tech shopping assistant. You've got a small computer called an Arduino Uno that connects to various devices: an RFID reader (which reads special tags attached to products), a Bluetooth module (for wireless communication), and a display screen. When a customer uses this system, they have two ways to log in: by entering their username and password or by using a special card that's like a digital ID. This card stores a unique code that represents the customer. Once logged in, the mobile app shows a cool display with two main sections. One section reminds customers of what they bought previously, making it easier to remember and plan their shopping. The other section showcases discounts and special offers on products. After logging in, the app wirelessly fetches the customer's shopping history from a central server and displays it. This helps customers keep track of what they've bought before and take advantage of any ongoing promotions. Now, when a customer selects a product from their previous list or the promotions, they can use the app to see a map of the store. The map helps them find where the selected product is located. When they get to the product's location, they can use the RFID reader to scan the product's tag. This sends information to the app about the product, showing its details on the mobile screen . The customer can then decide whether to add it to their shopping list. The Arduino Uno communicates with the mobile app wirelessly using Bluetooth. So, when a product's tag is scanned, this info is sent to the app, which updates the shopping list on the screen. Essentially, it's like having a personal shopping assistant in your phone that remembers what you like to buy, shows you great deals, helps you find products in the store, and updates your shopping list as you shop. The primary goal is to enhance services by streamlining processes and reducing time-consuming tasks. The proposed architecture and services are focused on optimizing the shopping journey for efficiency and convenience. A key aspect is personalization, where the supermarket's management system can customize shelves and displays based on individual preferences, offering a tailored shopping experience. The system's backbone is wireless communication, enabling seamless connectivity between RFID sensors, the mobile app, and the supermarket's backend system. This integration ensures fast and accurate communication among different components, enhancing overall efficiency. Ultimately, these proposals aim to modernize retail practices by combining technology, personalized experiences, efficiency gains, and sustainability efforts, creating a consumer-centric and responsible retail environment.

MFRC522

The MFRC522 module is a fundamental part of RFID technology, comprising several key hardware components. At its core is the RFID chip, responsible for communicating with RFID tags via radio waves. This communication is facilitated by an integrated antenna that emits and receives signals. The module interfaces with a microcontroller, such as an Arduino or Raspberry Pi, through a microcontroller interface, typically using communication protocols like SPI or I2C. A stable power supply is essential for the module's operation, usually ranging from 3.3V to 5V. Control pins enable functions like activating the antenna, initiating RFID operations, and resetting the module. LED indicators may be present to signal tag detection or data transfer, and some versions may include a UART interface for direct serial communication. These components work together seamlessly to enable RFID functionality for applications like access control, inventory management, and more. The MFRC522 is a widely used RFID (Radio-Frequency Identification) module that operates in the 13.56 MHz frequency range. It's commonly employed in various applications, including access control systems, contactless payment systems, and inventory tracking .

RFID Chip: The core component of the MFRC522 module is the RFID chip itself. This chip communicates with RFID tags using radio waves and can read and write data to compatible tags.

Antenna: The module includes an integrated antenna that emits radio waves and receives signals from RFID tags. The antenna's design and size affect the module's range and performance.

Microcontroller Interface: The MFRC522 module interfaces with a microcontroller, such as an Arduino or Raspberry Pi, to process RFID data. It uses communication protocols like SPI (Serial Peripheral Interface) or I2C (Inter-Integrated Circuit) to exchange data with the microcontroller.

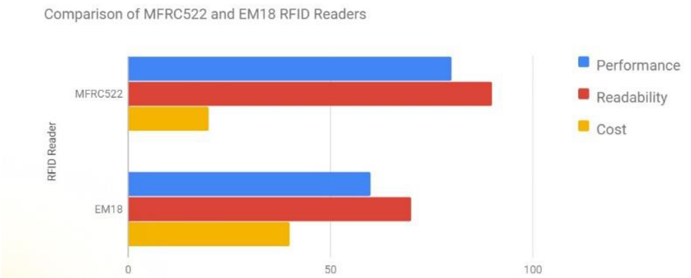
Power Supply: The module requires a stable power supply, typically 3.3V or 5V depending on the model. It may include voltage regulators or level shifters to ensure compatibility with different microcontroller systems.

Control Interface: The MFRC522 module has control pins for various functions, such as enabling or disabling the antenna, initiating RFID operations like reading or writing data, and resetting the module .

RESULT AND DISCUSSION

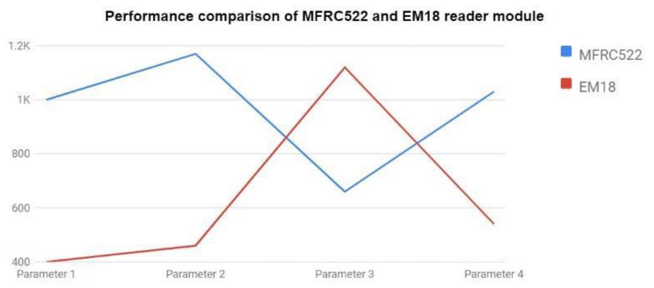
The MFRC522 module stands out as the preferred option compared to the EM18 reader module for RFID shopping cart systems, boasting numerous advantages. Its seamless integration with widely used platforms such as Arduino makes setup and usage straightforward. Additionally, the MFRC522 module offers advanced functionalities, including support for multiple RFID tag protocols and built-in security measures, enhancing data management and protection. With a higher read range and superior readability capabilities, it ensures efficient scanning of RFID tags, contributing to improved inventory management and a smoother shopping experience for customers. Furthermore, the MFRC522 module benefits from a robust community of developers, providing ample support and resources for troubleshooting and customization. Despite slightly higher initial costs, its long-term cost-effectiveness makes it a strategic investment for retail operations, optimizing processes and driving overall efficiency in the retail environment.

a) Readability and Cost comparison Graphs: The MFRC522 RFID module surpasses the EM18 reader module in terms of readability and cost-effectiveness. It excels with a longer reading range of 3-5 cm compared to EM18's 2-3 cm, ensuring more reliable RFID tag detection in shopping carts. The MFRC522 also boasts higher data transfer rates of up to 10 Mbps, leading to faster communication and item processing, thereby enhancing system efficiency. Additionally, its robust security features, including encryption and authentication protocols, offer better data security compared to EM18. While the EM18 module may be slightly more cost-effective, particularly relevant for budget-conscious projects, the MFRC522's lower power consumption makes it more suitable for battery-powered applications, contributing to better overall system performance.

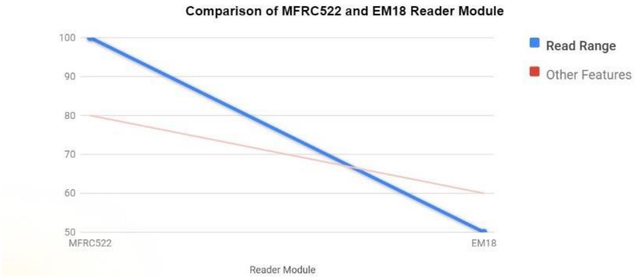


b) Performance comparison Graphs

The comparison between MFRC522 and EM18 RFID readers boils down to several key factors. MFRC522, being more advanced and versatile, offers faster read speeds, wider RFID tag support, and better integration with microcontrollers for complex applications. In contrast, EM18 readers are simpler, more affordable, and suited for basic RFID tasks with fewer tag compatibility options. Choosing between them depends on the specific needs of the RFID system, with MFRC522 preferred for higher performance and EM18 for budget-friendly simplicity.



c) Overall comparison Graphs: The MFRC522 RFID module and EM18 reader module each offer distinct advantages and considerations for RFID applications. The MFRC522 stands out with its longer reading range, higher data transfer rates, robust security features, and lower power consumption, making it efficient and reliable for various RFID systems, including those in shopping carts. Conversely, the EM18 module may be more cost-effective but has a shorter reading range and lower data transfer rates. The choice between these modules depends on factors such as budget constraints, specific application requirements, and the need for advanced security features. Overall, the MFRC522 excels in both performance and security aspects, while the EM18 may be a more economical choice suitable for simpler RFID applications.



Conclusion

In our proposed work, when a customer uses the RFID-enabled shopping cart, each time they add a product, the attached RFID tag is scanned automatically. This scanning process retrieves the necessary details related to the product. These details, such as product name, price, and quantity, are then transmitted to the microcontroller unit within the shopping cart. Based on predefined code and algorithms, the microcontroller processes this information and generates a detailed bill. This bill is updated in real-time, ensuring that every product addition reflects immediately in the bill. The generated bill is displayed on both the LCD screen attached to the shopping cart and on a web server. This dual display system enhances customer convenience by providing multiple avenues for viewing the bill. Customers can easily verify the accuracy of the bill and cross-check the products added against what they intended to purchase. The web server's role in displaying the bill adds a layer of accessibility, allowing customers to view their bill from their smartphones or other devices, further enhancing their shopping experience. In addition to adding products, the shopping cart system also accommodates product removal. If a customer decides to remove an item from their cart, they can simply use a push button on the cart and scan the RFID tag of the item to be removed. This action triggers the removal process, updating the bill instantly to reflect the change. This feature adds flexibility to the shopping experience, allowing customers to adjust their purchases as needed without any hassle. Overall, the integration of RFID technology, microcontroller processing, real-time bill updates, dual display options, and product removal functionality makes the shopping experience seamless, efficient, and customer-friendly.

REFERENCE

[1] Martinusa, Metta Saridewi Wahaba, Yudia, Hanry Hama. “Data Transmission Using RFID System on Smart Shopping Carts for Checkout Process Efficiency in Supermarket at Indonesia” 2020.

[2] Chakshu Manjunath, Nethravathi B, Nagamani NP, MB Raghav, Arjun A Sirole “IoT Based Smart Shopping Cart Using RFID”2019.

[3] Ms. Rupali Sawant, Kripa Krishnan, Shweta Bhokre, Priyanka Bhosale, “The RFID Based Smart Shopping Cart”2020.

[4] Susanna M Santhosh, Cemone P Babu, Jills Joseph, Preethu Benny,”Smart Shopping Cart using RFID Technology”2018.

[5] Manikandan Thiyagarajan, “RFID based Advanced Shopping Trolley for Super Market. 2019.