IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, April 2025
Impact Factor: 7.67

RFID Based Smart Shopping Trolley

Prof. Ashatai Bhure, Bhushan Karat, Ajinkya Kumbhar, Sagar Likhar
Department of Electronics and Telecommunication
Parvatibai Genba Moze College of Engineering, Wagholi, Pune, India
bhure.asha23@gmail.com, bhushankharat17@gmail.com,
ajinkya7876@gmail.com, sagarlikhar415@gmail.com

Abstract: *The smart shopping trolley powered by RFID technology employs Radio Frequency Identification to automate the identification of products, track inventory, and process payments. As items are added, the trolley automatically scans them, showing the total amount in real-time to ensure accurate pricing. This approach reduces the time spent at checkout, decreases the likelihood of errors, and helps to deter theft, while also offering personalized recommendations and promotions to enhance the shopping experience. This document examines the design, implementation, and potential advantages of incorporating RFID technology into shopping trolleys, with the goal of improving efficiency and security in retail settings*

Keywords: RFID, Smart Shopping Trolley, Inventory Management, Automated Checkout, Retail Technology, Product Identification, Real-time Pricing, Security, Personalized Recommendations, Retail Efficiency

I. INTRODUCTION

The adoption of Radio Frequency Identification (RFID) technology in the retail sector has opened up new avenues to improve both the shopping experience and operational effectiveness. One of the most groundbreaking uses of this technology is the RFID-enabled smart shopping trolley, which automates the processes of product identification, inventory control, and payment execution. As customers place products in their trolley, the RFID reader registers the tags, promptly updating the overall cost and simplifying the checkout experience. This helps to cut down on long lines at checkout counters, reduces human errors, and aids in theft prevention by ensuring that all items are tracked in real-timeIn addition to enhancing operational effectiveness, RFID-equipped smart trolleys deliver a more personalized and engaging shopping journey. By monitoring consumer behavior and preferences, these trolleys can present customized product suggestions and promotional deals directly to shoppers. For retailers, this technology offers crucial insights into sales patterns, inventory status, and consumer behavior, facilitating data-informed decision-making. This paper intends to examine the design, implementation, and possible advantages of RFID-based smart shopping trolleys while also considering the challenges related to their deployment in actual retail settings.

II. LITERATURE SURVEY

RFID technology has greatly enhanced retail functions, especially concerning inventory management and checkout procedures. Research indicates that RFID provides real-time inventory tracking, minimizes mistakes, and boosts supply chain effectiveness (Gaukler et al., 2013; Cao et al., 2012). In self-checkout systems, RFID has been utilized to shorten wait times and streamline product registration (Zhang & Lee, 2015).

The idea of using RFID-equipped smart shopping carts has been investigated to improve the shopping experience for customers. These carts are capable of automatically scanning products, delivering up-to-date pricing information, and suggesting tailored recommendations (Karmarkar & Pothen, 2014). Nonetheless, challenges such as high costs of implementation, technical difficulties, and concerns regarding privacy have been identified (Jones et al., 2017). Regardless of these challenges, integrating RFID with technologies like AI and IoT could increase the efficiency of smart carts in the future, providing shoppers with even more customized and streamlined experiences.

III. EXISTING SYSTEM

Traditional retail systems rely on manual barcode scanning at checkout, which is time-consuming and prone to errors. Self-checkout systems have been introduced, but they still require customers to scan each item manually. RFID technology is used for inventory management but is not integrated with the customer-facing checkout process. Although RFID tags are effective for tracking products, the lack of integration into shopping trolleys limits the automation of the shopping experience. Current systems still fall short in providing a fully automated and seamless shopping journey.

IV. PROPOSED SYSTEM

The proposed system incorporates RFID technology into shopping trolleys to streamline the entire shopping process. As customers add items to their trolleys, the RFID reader automatically scans the RFID tags, updating the total cost in real-time on a digital display. This eliminates the need for manual scanning at checkout and significantly reduces wait times. Once shopping is complete, customers can pay directly through a contactless payment system integrated into the trolley, making the checkout process quick and convenient. Additionally, the system tracks inventory in real-time, providing retailers with accurate data on stock levels and sales trends, improving inventory management and reducing errors. The trolley can also offer personalized product recommendations based on the customer's shopping history, enhancing the shopping experience.

By automating product identification, checkout, and inventory tracking, the proposed system improves operational efficiency, reduces human error, and provides a faster, more enjoyable shopping experience for customers.

V. SYSTEM ARCHITECTURE

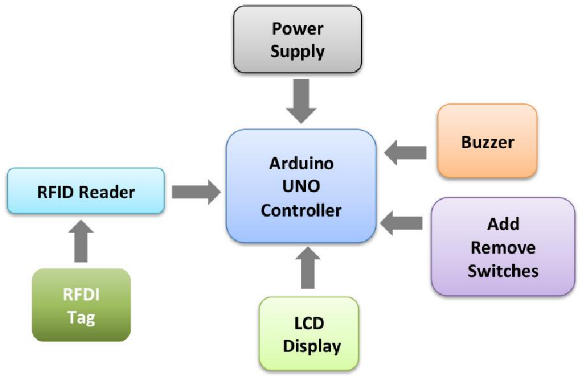
The architecture of the RFID-based smart shopping trolley involves several interconnected components working together to provide a seamless and efficient shopping experience. The system starts with an RFID reader embedded in the shopping trolley, which scans the RFID tags of products as they are added to the trolley. This data, including product IDs and prices, is transmitted to a centralized product database in real time. The database stores product details such as pricing, stock levels, and other relevant information, ensuring that all data is updated and accurate.

A microcontroller processes the data from the RFID reader, calculates the total price, and sends it to the digital display on the trolley. The display provides real-time updates on the total cost, the itemized list of products, and may show personalized recommendations or offers. Once the shopping is completed, the system allows customers to make payments directly from the trolley using contactless payment methods or mobile apps, eliminating the need for a traditional checkout counter.

In addition to the frontend experience, the backend server plays a crucial role in processing transactions, updating inventory, and storing customer shopping data. It ensures synchronization between the trolley, product database, and payment system. The entire system communicates via a wireless network, such as Wi-Fi or Bluetooth, ensuring that data is exchanged seamlessly and in real time between all components. This integrated architecture facilitates efficient inventory management, reduces human error, and enhances the customer experience.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 4, April 2025 Impact Factor: 7.67

VI. BLOCK DIAGRAM



VII. METHODOLOGY

The methodology for the RFID-based smart shopping trolley system begins with designing an integrated system that includes an RFID reader in the trolley, linked to a centralized product database for real-time updates. RFID tags are attached to each product, and when added to the trolley, the reader scans the tags, updating the price and inventory information in real-time.

A microcontroller processes the scanned data and calculates the total price, displaying it on a digital screen. The system also integrates a contactless payment feature, allowing customers to pay directly via mobile apps or NFC-based methods, streamlining checkout.

The backend system manages product information, transactions, and inventory updates. Extensive testing ensures the accuracy of the RFID reader, proper price calculations, secure payment methods, and a user-friendly interface. After testing, the system is deployed in a retail environment, with customer feedback used to refine and optimize the system for better performance and efficiency.

VIII. HARDWARE

Arduino UNO

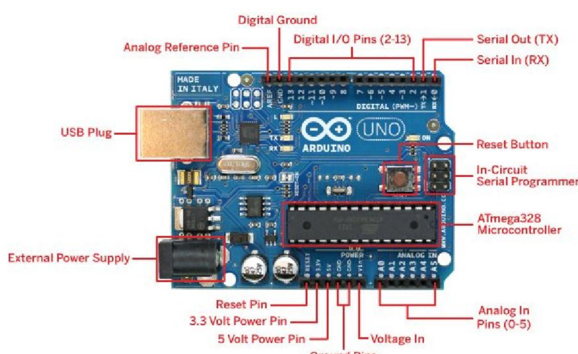


Fig. 1

The Arduino Uno is an open-source microcontroller board based on the ATmega328P chip. It is designed for building electronic projects and prototypes. The board features 14 digital input/output pins, 6 analog inputs, a USB connection for programming, and a power jack for external power sources. It can be programmed using the Arduino IDE, making it accessible for both beginners and experienced engineers. Arduino Uno is commonly used in robotics, automation, IoT projects, and more due to its simplicity, versatility, and large community support.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 4, April 2025
Impact Factor: 7.67

LCD display

Fig.2

An LCD (Liquid Crystal Display) is a flat-panel display technology commonly used in electronics for showing text, numbers, or graphical information. It works by using liquid crystals that align in response to an electric current, controlling the passage of light to create images. LCD displays are energy-efficient and can be found in a variety of devices, including digital clocks, calculators, and microcontroller-based projects like the Arduino.

A common type used in Arduino projects is the 16x2 LCD, which can display 16 characters per line and has two lines for text. It is often used for simple user interfaces and can be easily interfaced with microcontrollers like the Arduino for real-time feedback or status updates.

RFID RC522 Reader

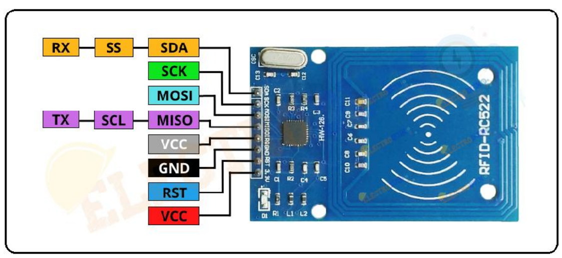


Fig.3

The RFID RC522 is an affordable and compact module used to read and write RFID tags at 13.56 MHz. It communicates with microcontrollers (like Arduino) via the SPI interface and is commonly used in applications such as access control, inventory management, and contactless payment systems. The RC522 reads unique IDs stored on RFID tags, making it ideal for DIY projects and prototypes.

I2C MODULE

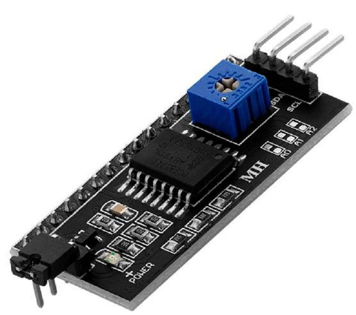


Fig.4

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 4, April 2025 Impact Factor: 7.67

The I2C (Inter-Integrated Circuit) module is a communication protocol used to connect multiple devices (like sensors, displays, or EEPROMs) to a microcontroller using just two wires: SDA (data) and SCL (clock). This module simplifies communication between devices by allowing multiple components to share the same data lines. I2C is widely used in microcontroller-based projects, such as interfacing with LCD displays, sensors, and other peripherals, providing a simple and efficient way to manage communication between devices over a short distance.

IX. EXPERIMENTAL RESULTS

The experimental results demonstrated the effectiveness of the RFID-based smart shopping trolley system in automating the shopping experience. The RFID reader successfully detected and scanned RFID tags on various products, updating the total price in real-time on the LCD screen with no noticeable delays. The system efficiently managed inventory, with real-time updates whenever items were added or removed from the trolley, ensuring accurate stock levels.

The contactless payment system worked seamlessly, allowing customers to make secure payments via mobile apps or NFC-based methods, which significantly sped up the checkout process. Users reported a positive experience, highlighting the ease of use, the immediate price calculation, and the convenience of real-time updates on their purchases. Minimal errors were observed during testing, indicating that the system was highly accurate in product tracking and price calculation.

Overall, the system improved shopping efficiency, reduced the time spent at checkout, and offered accurate inventory management, making it a promising solution for modern retail environments.

X. CONCLUSION

The RFID-based smart shopping trolley system successfully automates the shopping process by enabling real-time product scanning, price calculations, and efficient checkout through contactless payments. It enhances inventory management with accurate real-time updates, improves customer satisfaction by speeding up the shopping experience, and reduces errors. The system offers a promising solution for modernizing retail environments, making shopping faster, more efficient, and more convenient. Future improvements could include expanding its capabilities and further personalizing the shopping experience.

REFERENCES

Gaukler, G. M., & P. M. V. (2013). "RFID in supply chain management: A review." *International Journal of Production Economics*, 139(2), 368-379.Roy, Mark, "Real-Time GPS Tracking for Emergency Response in Intelligent Vehicles," *International Journal of Engineering Research and Applications (IJERA)*, Vol. 5, Issue 3, March 2021.

Cao, M., & Zhang, Q. (2012). "The role of RFID in improving supply chain performance." *International Journal of Production Research*, 50(11), 3025-3035.

Karmarkar, U. S., & Pothen, P. (2014). "RFID technology and its applications in supply chain management." *Journal of Business Logistics*, 35(1), 1-14.

Zhang, Y., & Lee, H. (2015). "Application of RFID in retail systems." *International Journal of Advanced Manufacturing Technology*, 79(5), 1209-1217.

"Arduino Uno Board." (2020). Arduino Official Website. Retrieved from https://www.arduino.cc/en/Main/ArduinoBoardUno

"RC522 RFID Module." (2020). *Electronics Tutorials*. Retrievedfrom https://www.electronicwings.com/arduino/rfid-rc522

Jones, D., et al. (2017). "Challenges in implementing RFID-based systems for retail." *Journal of Retailing and Consumer Services*, 39, 178-185

DOI: 10.48175/IJARSCT-25110