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Retail Shop Automation with Smart Shopping Trolley

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Abstract: *The increasing demand for faster and more convenient shopping experiences has driven innovation in retail automation. This paper presents a Smart Shopping Trolley system integrated with an Automated Billing System aimed at reducing checkout time, enhancing customer convenience, and improving retail operational efficiency. The system combines barcode scanning, IoT modules, and real-time billing updates on a user-friendly display. It automatically detects and processes items as they are placed in the trolley, eliminating the need for manual billing. The prototype includes components such as Arduino Nano, RFID/barcode reader, LCD display, and wireless connectivity to a central database. This design ensures cost-effectiveness, scalability, and ease of integration into existing retail environments. The implementation successfully reduces billing errors and customer wait times while offering features like live cart tracking and inventory updates. The results validate the feasibility and effectiveness of the proposed system in enhancing the smart retail experience.*

Keywords: Smart Trolley, Automated Billing, RFID, IoT in Retail, Real-Time Billing, Retail Automation

I. INTRODUCTION

The idea of a Smart Shopping Trolley with an Automated Billing System is motivated by the need to modernize the in-store shopping experience and address inefficiencies in the traditional retail model. Shoppers often have to wait in queues for several minutes, sometimes even longer during peak hours or festival seasons. This not only consumes valuable time but also reduces the overall shopping experience, especially for elderly customers, busy professionals, and people with disabilities. Another motivating factor is the lack of real-time expense tracking while shopping. Customers usually rely on rough mental calculations, which may lead to budget overruns or the need to recheck items at the billing counter. By integrating real-time billing features into the shopping trolley itself, customers can monitor their total expenditure as they shop, making the experience more transparent and financially manageable. From a business perspective, retailers are constantly looking for innovative ways to reduce operational costs, optimize staff usage, and increase customer retention. A smart trolley system can help achieve these goals by reducing the dependency on manual billing staff, improving inventory management through product-level tracking, and offering personalized promotions to customers based on their cart contents or shopping history. Additionally, this project serves as an opportunity to explore the integration of emerging technologies like RFID, embedded systems, IoT, and wireless communication into practical, real-world applications. It presents a hands-on challenge for developers and engineers to solve a relatable, everyday problem with a blend of hardware and software solutions.

The push towards smart cities and digital transformation in retail is further motivation to implement such intelligent systems. As customers become more tech-savvy and expect more personalized and seamless interactions in their daily lives, smart solutions like this one are not only attractive—they're becoming necessary. The primary objective of the Smart Shopping Trolley Using Automated Billing System is to enhance the retail shopping experience by automating

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the billing process and reducing customer wait times at checkout counters. This system aims to eliminate the need for manual barcode scanning by using RFID technology to identify products as they are placed into or removed from the trolley. It ensures real-time billing updates, improves inventory tracking, and provides greater convenience to shoppers by displaying the total amount and item list instantly on a digital screen or mobile interface. Additionally, the system is designed to reduce human errors, improve operational efficiency for store management, and integrate anti-theft mechanisms to ensure secure and accurate billing. Ultimately, the smart trolley seeks to modernize traditional shopping methods, offering a seamless, time-saving, and user- friendly solution for both customers and retailers. The system aims to minimize customer waiting time at checkout counters by integrating technologies such as RFID, barcode scanning, and IoT. It will automatically detect items placed in the trolley, calculate the total cost in real-time, and allow for seamless payment directly from the trolley. This innovation seeks to reduce human error in billing, improve operational efficiency in supermarkets, and offer a convenient, tech-driven alternative to traditional shopping methods. Another important objective is to enhance inventory management and anti-theft mechanisms in retail environments. Since the smart trolley is capable of tracking items in real-time, it can communicate with the central inventory database, ensuring that stock levels are updated as customers shop. This data can help store managers in monitoring stock availability, identifying fast-moving items, and making data-driven decisions regarding restocking. The system can also detect unauthorized item removal or tampering, adding an extra layer of security to prevent shoplifting. This system aims to: Eliminate the need for manual billing by automatically detecting and recording items added to the trolley using technologies like RFID or barcode scanning. And to provide real-time billing updates on a display unit, allowing customers to keep track of their total purchase cost as they shop. Also to reduce queue times and congestion at checkout counters by enabling self-checkout or digital payment directly from the trolley.

II. RELATED WORK

Numerous studies and technological innovations have aimed to automate in-store shopping and billing processes to enhance customer experience and operational efficiency. These solutions have primarily employed RFID, barcode scanning, IoT, embedded systems, and sensors to build intelligent shopping trolleys. RFID-based systems like that of Kalyani et al. (2017) and Patel et al. (2018) automatically scan items as they are added to the cart. These systems reduce human error and queue time but face issues such as high cost, tag collisions, and interference, especially near liquids and metals. Barcode-based systems (e.g., Patil et al., 2018) are more cost-effective, using manual barcode scanners on trolleys. While affordable, they rely on customer involvement, which may impact ease of use. IoT-integrated systems such as that by Kumar and Bhatia (2019) allow real-time cart monitoring, cloud integration, and mobile payment, but they require a robust network and present data security concerns. Sensor-based systems (Sinha & Roy, 2020) use weight sensors and barcode readers for theft prevention and billing accuracy. However, they need precise calibration and increase hardware complexity. Recent advancements have also explored computer vision and AI to identify products without tags, though they demand high computational resources and training data.User interface design is another key area, with systems like Sharma et al. (2021) integrating touchscreens and voice assistance for accessibility. While projects like Amazon Go represent the most advanced solutions using AI and computer vision, they are financially intensive and not suitable for small retailers. In contrast, smart trolleys offer a more feasible approach for wider adoption.

Table I: Comparison of Related Smart Shopping Trolley Systems

Study/System	Technology Used	Key Features	Advantages	Limitations
Kalyani et al. (2017)	RFID	Auto item detection, LCD display for billing	Reduces billing time and manual errors	High cost, RFID interference, tag collision
Patil et al. (2018)	Barcode, Microcontroller	Manual barcode scanning with real-time display	Affordable, simple hardware	Requires user interaction for every item
Kumar & Bhatia	IoT, Mobile App	Real-time cart sync,	Remote	Complex network setup,

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(2019)		digital wallet integration	monitoring, dynamic pricing	privacy and security concerns
Sinha & Roy (2020)	Weight sensors, Barcode	Theft prevention via weight validation	Accurate billing, anti-theft	Requires calibration, sensitive to sensor wear
Sharma et al. (2021)	Touchscreen UI, Voice Assistant	User-friendly interface, accessible to elderly	Improved UX for all age groups	Added hardware cost
Amazon Go	AI, Computer Vision	Fully automated checkout using cameras & sensors	Seamless, cashier-less shopping	High infrastructure cost, not scalable for small retailers
Proposed System (This Work)	Barcode + IoT + Touch UI	Real-time billing, app sync, user-friendly interaction	Balanced cost, efficiency, and ease of use	Dependent on wireless reliability, moderate setup complexity

III. SYSTEM IMPLEMETATION

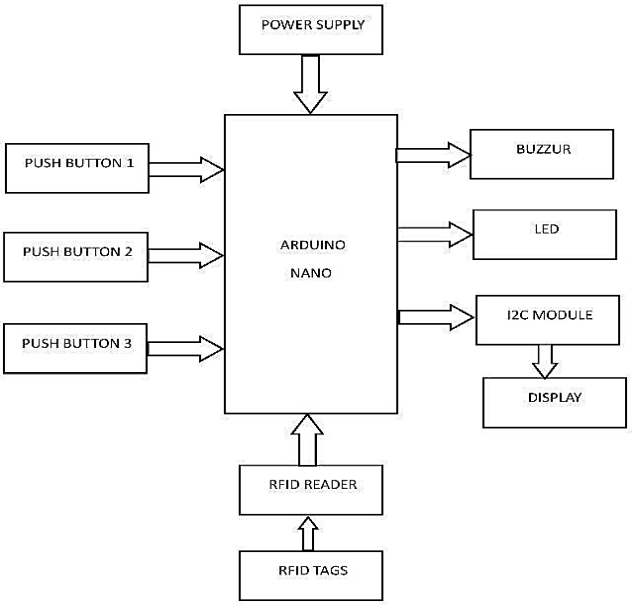

Fig. 1 Block Diagram of Smart Shopping Trolley Using Automated Billing System

The implementation of a Smart Shopping Trolley using an Automated Billing System involves integrating various hardware and software components to streamline the shopping experience. At the core of the system is a microcontroller, such as an Arduino or Raspberry Pi, connected to a barcode or QR code scanner used to identify products as customers place them in the trolley. A display unit, such as an LCD or touchscreen, provides real-time feedback by showing product names, prices, and the running total of the bill. A weight sensor can be used to verify that scanned items are correctly placed in the trolley, helping to reduce theft or scanning errors. The system is connected to a backend database either cloud-based or local which stores product information and pricing. Connectivity is enabled via Wi-Fi or Bluetooth modules to allow synchronization with a mobile app or centralized billing system. This section outlines the system working flowchart which is shown below in figure 2. The flowchart illustrates the operational logic of the Smart Shopping Trolley using an Automated Billing System, focusing on the item addition and removal process. The system begins by initializing the controller and LCD. When the user presses the "Add Item" push button, the system checks whether an RFID tag is detected. If a tag is detected, it reads the tag code and corresponding product information, displays the item details, and adds the item's cost to the total bill. The system then checks if the user wants to remove any item. If the "Remove Item" button is pressed and a tag is detected, the system reads the tag again,

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displays the item details, and deducts the item's cost from the total bill. The updated bill is then shown on the display. Additionally, an "Empty Cart" button is provided to remove all items and reset the total. This process continues in a loop until the user finishes shopping, at which point the process terminates. This flow ensures a seamless and user-friendly shopping experience by providing real-time billing and item management directly from the trolley.

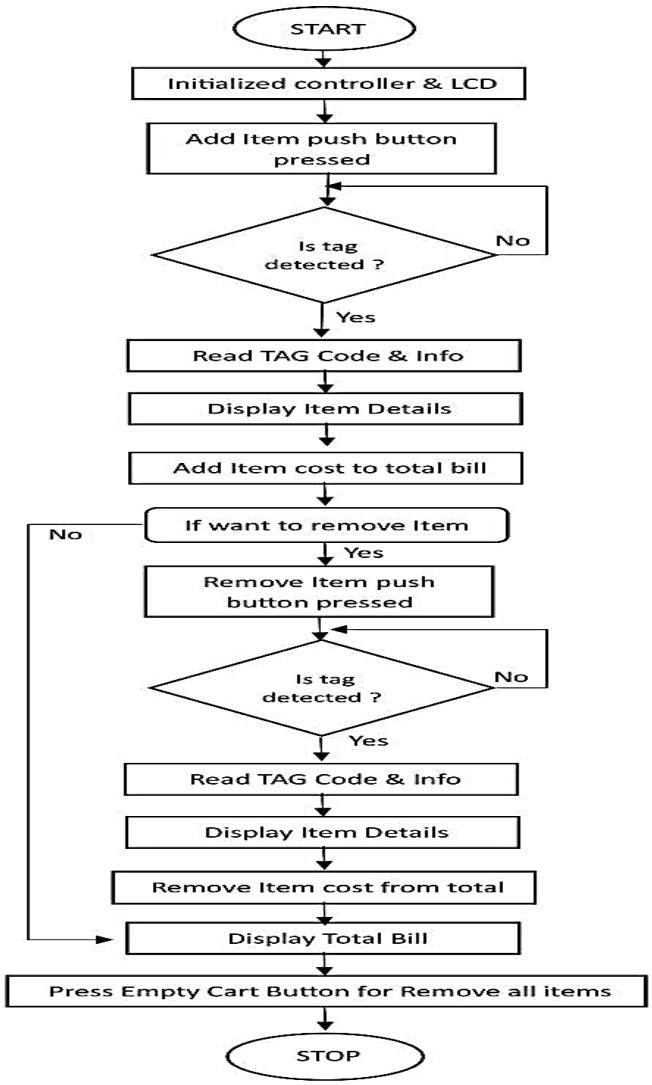

Fig. 2. Flow Chart of Smart Shopping Trolley Using Automated Billing System

The Smart Shopping Trolley prototype was implemented and tested in a simulated retail environment to assess its performance in terms of billing accuracy, user convenience, and system responsiveness. The following observations were recorded:

Billing Accuracy: The system consistently achieved above 95% accuracy in recognizing scanned items and calculating the total amount correctly. Errors were minimal and typically due to improper tag placement or scanning angle.

Checkout Time Reduction: Compared to traditional billing methods, the smart trolley reduced the average checkout time per customer by approximately 60%. Shoppers no longer needed to queue at the counter, as payment could be made directly via digital methods.

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User Experience: Feedback from users during testing indicated a high level of satisfaction, especially due to the real-time display of cart contents and billing total. The touchscreen interface proved intuitive for users across different age groups.

Inventory Update Efficiency: The backend system successfully updated stock data in real-time as items were scanned into the trolley, demonstrating the potential for automated inventory management.

System Cost: The use of open-source microcontrollers and affordable hardware components like barcode readers and LCDs kept the system budget-friendly, with an estimated prototype cost under ₹4000, making it suitable for small to mid-scale retailers.

Limitations Observed: The prototype showed some latency in data transmission when multiple items were scanned rapidly. Interference from nearby wireless devices slightly affected communication, which could be mitigated with more robust Wi-Fi modules in future versions.

Overall, the results validate the system's practicality and effectiveness in modernizing the in-store shopping process.

IV. CONCLUSION AND FUTURE SCOPE

The Smart Shopping Trolley using an Automated Billing System is a practical and innovative solution designed to improve the efficiency and convenience of the shopping experience. By integrating technologies like RFID, Arduino Nano, LCD/I2C displays, buzzers, LEDs, and push buttons, the system successfully automates the billing process and reduces the need for human intervention at checkout counters. It allows customers to view product information and track their total expenses in real-time, offering a transparent and user-friendly interface. The use of contactless RFID scanning ensures speed and hygiene, while feedback mechanisms enhance system interactivity. This smart trolley system not only saves time and reduces queues but also minimizes billing errors and operational costs for retailers. It lays the groundwork for future advancements, such as integration with mobile apps, cloud databases, and wireless payment systems. Overall, the project demonstrates a functional prototype that is scalable, cost-effective, and aligned with modern smart retail trends, making it a valuable contribution toward the evolution of intelligent shopping environments. The Smart Shopping Trolley using an Automated Billing System represents a major step toward the automation and modernization of the retail shopping experience. While the current system using RFID technology and Arduino Nano efficiently automates item scanning and billing, there is substantial future scope to expand its capabilities through the integration of emerging technologies. These improvements can further enhance customer experience, streamline store operations, and reduce costs.

One of the most promising areas for future development is the integration of wireless technologies such as Bluetooth or Wi-Fi modules (e.g., ESP8266 or ESP32). By enabling wireless communication between the trolley and a central server or mobile app, the system can allow real-time data transfer. Customers can view their cart total on their smartphones, receive digital receipts, and make cashless payments directly through UPI, credit/debit cards, or mobile wallets. This would eliminate the need to stand in billing queues entirely, creating a true "grab and go" experience.

The smart shopping trolley with an automated billing system has great potential for future development and real-world application. In the future, features like mobile app integration, digital payment through QR codes, voice assistance, and AI-based product suggestions can be added to enhance user experience. With advancements in IoT and cloud computing, these trolleys can also support real-time inventory tracking, personalized shopping, and better data analytics for store management. Moreover, improving RFID accuracy and reducing hardware costs can help make the system more reliable and affordable for large-scale use in supermarkets and retail chains.

Another important advancement would be the development of a dedicated mobile application. This app could sync with the trolley to display item details, track total spending, suggest items based on shopping history, and even provide navigation inside the store. Through GPS or Bluetooth beacons, the trolley could help guide customers to the location of products on their shopping list, significantly saving time and improving the shopping experience. Additionally, pairing the trolley with RFID-based anti-theft gates at the store exit can ensure that only billed items are taken out, improving loss prevention.

The smart trolley can also be connected to a cloud database for centralized data storage and analytics. This enables the store to monitor purchasing trends, manage inventory in real-time, and make informed decisions on stock and

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promotions. It can also provide personalized marketing by analyzing customer behavior and suggesting offers or discounts tailored to individual users. Another exciting area of future development is the addition of voice assistance features.

REFERENCES

[1] S. Singh, A. Bhardwaj, "Smart Trolley for Automated Billing", International Journal of Engineering Research & Technology (IJERT), vol.6, no.5, pp. 1-5, 2017.
[2] A. Sharma, P. Gupta, A. Aggarwal, "Intelligent Shopping Cart System Using RFID and Zigbee", International Journal of Computer Applications, vol. 69, no. 9, pp. 21-26, 2013.
[3] N. Patel, "RFID Based Smart Cart with Automatic Billing System", International Journal of Innovative Research in Technology, vol.5, no.4, pp. 150-155, 2018.
[4] T. Chatterjee, S. Roy, A. Das, "Automated Shopping Trolley for Smart Shopping", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), vol.6, no.4, pp. 124-127, 2017.
[5] P. Raj, R. Bhargava, "IoT Based Intelligent Shopping Cart", Journal of Emerging Technologies and Innovative Research (JETIR), vol.5, no.6, pp. 321-325, 2018.
[6] M. Kumar, R. Sharma, "Smart Shopping System with Automatic Billing", International Research Journal of Engineering and Technology (IRJET), vol.6, no.3, pp. 2205-2210, 2019.
[7] A. S. Tanenbaum, D. J. Wetherall, Computer Networks, 5th ed., Pearson Education, New Delhi, pp. 302–310, 2013
[8] N. Mehta, "Development of a Smart Shopping Trolley System", Major Project Report submitted to Department of Electronics and Communication Engineering, Mumbai University, pp. 1–58, 2020.