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Smart Scan Shopping Trolley Using IOT

Ch.Swetha[1], M.Siri Vennela[2], B.Tejaswini[3], R.Poojitha[4], K.Sathwika[5]

Assistant Professor, Department of Information Technology, Vidya Jyothi Institute of Technology (A), Hyderabad, Telangana, India[1]

UG Students, Department of Information Technology, Vidya Jyothi Institute of Technology (A), Hyderabad, Telangana, India[2,3,4,5]

Abstract: The Smartscan Shopping Trolley is an innovative system designed to simplify and automate the billing process in supermarkets. This project integrates a microcontroller-based system with a barcode or QR code scanner mounted on a trolley, allowing customers to scan items before placing them into the cart. Once scanned, the system retrieves the product information and automatically updates the total cost, which is displayed in real time on an LCD screen, If an item is removed, the user can rescan it to deduct the price from the total. To ensure accuracy and prevent unauthorized additions, the system includes an error detection mechanism that triggers a buzzer or voice alert when an invalid or unregistered product is scanned. Additionally, loT functionality can be incorporated to transmit billing data to a mobile application or cloud platform, enhancing user convenience and enabling real-time monitoring. This project reduces waiting time at billing counters, improves shopping efficiency, and demonstrates the practical application of embedded systems and loT in smart retail environments.

Keywords: IoT (Internet of Things), Smart Shopping Trolley, Barcode Scanner, QR Code System, Automated Billing System, Embedded Systems, Real-Time Processing, RFID, Smart Retail, Arduino, ESP8266

I. INTRODUCTION

In recent years, supermarkets have become much busier due to the increasing number of customers. One common problem faced by shoppers is the long waiting time at billing counters, especially during weekends and holidays. Even though barcode billing systems have made the billing process more accurate than manual methods, customers still need to stand in queues to complete their purchases. On the other hand, RFID-based shopping systems can reduce waiting time, but they are expensive because every product in the store must be fitted with an RFID tag. This makes them difficult to implement in many supermarkets.

With the rapid development of the Internet of Things (IoT), it has become possible to build smart systems that can automate many everyday tasks. IoT combines sensors, microcontrollers, wireless communication, and cloud technology to allow devices to exchange information in real time. These technologies have opened up new possibilities for improving the shopping experience by making shopping trolleys smarter and more efficient.

The SmartScan Shopping Trolley using IoT is designed to overcome the limitations of existing billing systems. The trolley is built using an ESP32 microcontroller, a TTL barcode scanner, a 16×2 I2C LCD display, and wireless communication. As customers place products into the trolley, they simply scan the barcode of each item using the scanner. The system then identifies the product from the stored database, displays the product name and price on the LCD, and automatically updates the total bill. This allows customers to keep track of their spending while they shop. If a customer decides not to buy an item, scanning the same barcode again removes the product from the bill. The system also produces a buzzer alert whenever an invalid or unknown barcode is scanned, helping to avoid billing mistakes.

The main goal of this project is to make the shopping process faster, easier, and more convenient for both customers and supermarket staff. By reducing the need for manual billing, the system helps minimize waiting time and improves billing accuracy. Since the trolley is IoT-enabled, the billing information can also be sent to a central server or cloud platform for digital record keeping. In the future, this system can be connected with mobile applications, online payment methods, inventory management systems, and smart retail analytics. Overall, this project presents a simple, affordable, and practical IoT-based solution that can contribute to the modernization of supermarket billing systems.

II. CONCLUSION

The SmartScan Shopping Trolley using 1OT provides an efficient and intelligent solution for automated shopping and billing in supermarkets. The system successfully integrates the ESP32 microcontroller, Barcode/QR Code Scanner,

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LCD display, Wi-Fi communication, and IoT technology to simplify the shopping process and reduce manual billing operations

The Barcode/QR Code Scanner accurately identifies each product, while the ESP32 microcontroller efficiently processes the scanned information, retrieves the product details, calculates the total bill, and updates the LCD display in real time. The Wi-Fi communication module enables the billing information to be transmitted to a web application or cloud platform, allowing customers and store administrators to monitor shopping details remotely through mobile devices or computers

The project achieved stable performance, reliable wireless communication, low power consumption, fast product scanning, and accurate automatic billing. Overall, the SmartScan Shopping Trolley reduced checkout waiting time, minimized human errors, improved billing accuracy, enhanced customer convenience, and provided a practical and cost-effective solution for modern supermarkets, shopping malls, retail stores, and other smart retail environments.

LITERATURE REVIEW

Smart shopping systems based on the Internet of Things (IoT) have attracted significant research interest in recent years due to the growing demand for automated retail services and improved customer experiences. Researchers have proposed various smart trolley solutions that integrate technologies such as RFID, barcode scanning, computer vision, artificial intelligence (AI), and IoT communication to reduce billing time, improve accuracy, and eliminate long checkout queues. Most of these systems follow a common IoT architecture consisting of sensing devices for product identification, a processing unit for data handling, and a communication layer that transfers billing information to cloud platforms or retail management systems. This architecture provides a flexible and scalable framework for developing intelligent shopping solutions.

Several studies have focused on **RFID-based smart shopping trolleys** to automate the billing process. An RFID-enabled shopping cart proposed by Y. Joseph et al. reduced billing time and improved customer convenience by automatically detecting products placed inside the trolley. However, the requirement of RFID tags for every product significantly increases deployment cost, making the solution less suitable for small and medium retail stores. Similarly, automated shopping carts with RFID security features have demonstrated improved billing efficiency and theft prevention but require expensive infrastructure and dedicated RFID readers.

Recent research has explored **barcode-based shopping systems** as a more economical alternative to RFID. Barcode scanners provide reliable product identification without requiring modifications to existing products, making them easier to deploy in supermarkets. Studies on barcode-enabled smart trolleys have shown improvements in billing accuracy, reduced checkout delays, and enhanced user convenience. However, many of these systems still depend on centralized billing counters or lack support for real-time product removal and IoT-based communication.

Researchers have also investigated **AI-powered shopping carts** incorporating computer vision, product recommendation systems, autonomous navigation, and inventory forecasting. These systems enhance customer interaction and provide advanced retail analytics but require high computational resources, multiple sensors, and sophisticated hardware, resulting in increased implementation complexity and cost. Consequently, such solutions are generally unsuitable for cost-sensitive retail environments.

Based on the existing literature, it is evident that most smart shopping systems focus either on RFID technology or advanced AI techniques. Although these approaches improve automation, they often suffer from high deployment costs, increased system complexity, or limited flexibility. The proposed **SmartScan Shopping Trolley using IoT** addresses these limitations by combining an **ESP32 microcontroller**, a **TTL barcode scanner**, an **LCD display**, and **IoT-based communication** to provide real-time billing, automatic product addition and removal, invalid product detection, and cloud connectivity. The proposed solution offers a simple, cost-effective, and scalable approach suitable for practical deployment in supermarkets while reducing checkout time and improving the overall shopping experience.

PROPOSED SYSTEM AND METHODOLOGY

System Architecture

The proposed **SmartScan Shopping Trolley** is designed as an IoT-enabled automated billing system that integrates a TTL barcode scanner, ESP32 microcontroller, 16×2 I2C LCD display, buzzer, and Wi-Fi communication to simplify the shopping process. The ESP32 acts as the central processing unit, receiving barcode information from the scanner through UART communication. The scanned barcode is compared with the product database stored in the controller memory to identify the product and retrieve its corresponding details, including the product name and price.

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Whenever a valid product is scanned, the ESP32 automatically updates the total bill and displays the product information on the LCD screen in real time. If the same product is scanned again, the system interprets it as a removal request and deducts the corresponding amount from the total bill. Invalid or unregistered products activate the buzzer to notify the customer. Through the ESP32's built-in Wi-Fi capability, billing information can also be transmitted to a cloud platform or mobile application, enabling digital billing and future smart retail services. This architecture reduces manual billing effort, minimizes checkout delays, and provides an efficient and cost-effective shopping solution.

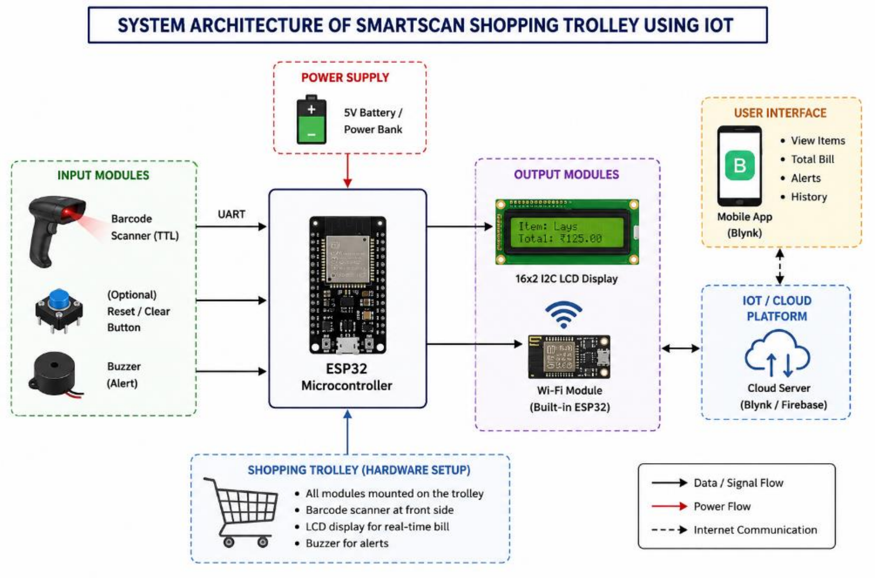

Fig -1: System Architecture of the Proposed IoT Based Smart Campus System

3.2 Hardware Components

The hardware is built entirely from parts that are cheap and easy to source. The list below summarises what is used and what each part does:

- ESP32 Microcontroller – Acts as the central processing unit of the system, processes barcode data, controls peripherals, and provides built-in Wi-Fi connectivity.
- TTL Barcode Scanner Module – Reads and decodes product barcodes and sends the scanned data to the ESP32 through UART communication.
- 16×2 LCD Display with I2C Module – Displays the product name, price, quantity, and updated total bill in real time using only two communication wires (SDA and SCL).
- Buzzer – Generates an audible alert for invalid or unregistered barcode scans and provides scan confirmation.
- I2C Module – Serves as an interface between the ESP32 and the LCD display, reducing wiring complexity.
- Breadboard – Used to assemble and test the electronic circuit without soldering.
- Jumper Wires – Provide electrical connections between the ESP32 and other hardware components.
- USB Cable / Power Supply – Supplies power to the ESP32 and is also used for programming the microcontroller.
- Shopping Trolley – Serves as the platform for mounting all hardware components and enables convenient product scanning during shopping.

RESULTS AND DISCUSSION

After assembling the SmartScan Shopping Trolley, each hardware module was tested individually to verify its functionality before integrating the complete system. The barcode scanner, LCD display, buzzer, and ESP32 communication were tested separately to ensure proper operation. Once all modules performed as expected, the complete prototype was evaluated by scanning different products, removing products by rescanning the same barcode, and verifying the updated bill displayed on the LCD. Table 2 summarizes the functional testing carried out on the prototype.

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The testing procedure involved scanning multiple products with different barcodes to verify product identification and billing accuracy. Invalid barcodes were intentionally scanned to ensure that the buzzer alert was activated correctly. Products were also rescanned to verify that the system successfully removed the item and deducted its price from the total bill. Each test was repeated several times to confirm consistent system performance.

Module	Test Condition	Observed Behaviour	Result
Barcode Scanner	Valid barcode scanned	Product detected successfully	Pass
Barcode Scanner	Invalid barcode scanned	Buzzer activated and error displayed	Pass
Billing System	Product added	Total bill updated correctly	Pass
Billing System	Same product rescanned	Product removed and bill updated	Pass
LCD Display	Product scanned	Product name, price and total displayed	Pass
IoT Communication	Billing data transmitted	Data successfully sent through Wi-Fi	Pass

All the functional tests were completed successfully, indicating that the proposed SmartScan Shopping Trolley performs reliable barcode scanning, real-time billing, and product management. The ESP32 processed barcode data with minimal delay, and the LCD displayed updated billing information immediately after each scan. The buzzer effectively notified users whenever an invalid barcode was detected, improving system reliability.

The experimental results demonstrate that the proposed system significantly reduces manual billing operations and checkout waiting time while maintaining accurate billing. Although the prototype depends on a stable Wi-Fi connection for cloud communication, all billing operations continue to function locally even if network connectivity is temporarily unavailable. The developed system therefore provides a practical, low-cost, and efficient solution suitable for supermarket automation.

FUTURE SCOPE

The current prototype demonstrates an efficient IoT-based shopping trolley for automated billing, but several enhancements can further improve its functionality. A dedicated mobile application can be developed to provide customers with digital bills, shopping history, and secure online payment options. Integration with cloud databases can enable centralized inventory management, customer analytics, and real-time synchronization across multiple shopping trolleys.

Future versions of the system may incorporate RFID, computer vision, or AI-based product recognition to eliminate the need for manual barcode scanning. Additional features such as voice assistance, multilingual support, automatic discount calculation, electronic payment gateways, and smart navigation inside supermarkets can further enhance customer convenience. These improvements will make the SmartScan Shopping Trolley more intelligent, scalable, and suitable for next-generation smart retail environments.

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