Smart Shopping Cart

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Abstract—In this paper a Smart Shopping Cart is proposed which eliminates long queues and manual scanning inefficiencies. Traditional billing relies on barcode scanning, which can be slow and error-prone. The proposed system streamlines this using an Arduino-based processing unit and load cell sensors to track item weight in real time. The Arduino processes this data, matches it with a preloaded product database, and generates an automatic bill displayed on a user-friendly interface. This eliminates the need for barcode scanning, reducing human effort and improving accuracy. The system also implements self-checkout seamlessly, while retailers benefit from optimized inventory management.

Keywords—Smart cart, weight sensors, Arduino, automation, retail technology, load cell sensors, barcode scanning, self-checkout, preloaded product database.

I. INTRODUCTION

Shopping is an integral part of life, but the traditional carts and checkout systems we've used have been inefficient for some time. Traditional shopping involves using barcodes and manually checking out. Not only are these processes inefficient, but they are also prone to errors and frustrating for the end user. The barcode process requires scanning each of the items in the user's cart individually, does not involve any sort of unique identification, and is based on older optical technology. It requires a lot of human resource, which in turn leads to billing errors, long checkout lines, and more frustration, which limits the number of customers entering the store and slows down sales processing. In today's digital world, Smart Shopping Carts take shopping and retail into the future by utilizing advanced technology, including the Internet of Things (IoT), machine learning, and embedded technology. Smart Shopping Carts, unlike traditional carts, can identify the products in the cart without scanning barcodes, instantly providing real-time checkout and digital payment options. This technology effectively redeems the customer from long checkout lines with more accurate and effective checkout processes, leading to a better experience overall. In addition to the improved usability that Smart Shopping Carts offer the retail industry, the carts also offer improved inventory tracking, increased accuracy, and reduced human costs. Automation-based features such as automatic pricing, individualized recommendations, and digital shopping lists respond to today's retail demands. Retailers benefit from improved efficiency and customers benefit from reduced stress. Advancing from antiquated shopping carts to Smart Shopping Carts is a significant advancement from what shoppers experience today. Retailers can provide shopping experiences that allow for convenience and eliminate the slow and manual aspects of shopping with intelligent automation solutions. The future of shopping is now, and Smart Shopping Carts are at the forefront of that transformation.

II. LITERATURE SURVEY

The concept of Smart Shopping Carts has evolved significantly over the past decade, driven by advancements in automation, embedded systems, and artificial intelligence. Various approaches have been explored to enhance the retail experience, addressing inefficiencies in traditional shopping methods.

One of the first innovations in automated shopping was the application of Radio Frequency Identification (RFID). As we know from [1], this technology used

RFID tags on products, which were wirelessly scanned by readers integrated into shopping carts. Although RFID minimized reliance on barcode scanning and manual checkout, it had some drawbacks. The high cost of implementation, interference, and security risks, including unauthorized signal interception, curbed its widespread use.

The second notable method included image recognition and computer vision [2]. Intelligent carts with cameras tried to recognize products with the help of machine learning-based algorithms. Even though this approach reduced the usage of barcode scanning, it had drawbacks like fluctuating lighting conditions, product orientation variations, and high computational demands, which made real-time image analysis expensive and unsuitable for widespread implementation.

Smart carts based on weight sensors [3] were also created, using preconfigured weight databases to identify products. Although promising, these systems were not accurate when several items were loaded at once and were not able to differentiate between products with similar weights.

Besides these approaches, [4] discussed that early Smart Shopping Carts also employed Raspberry Pi (RPI) as a microprocessor to handle calculations and process sensor data. Carts based on Raspberry Pi were a low-cost and space-efficient solution but limited in processing capability, particularly for processing multiple streams of real-time data. Their dependence on an external power supply and restricted memory made them inefficient for use in large-scale retail environments, so other microcontrollers were sought out.

In addition, the use of the Internet of Things (IoT) was a key factor in initial Smart Shopping Cart concepts. [5] IoT-based carts were linked to central retail management systems through Wi-Fi or Bluetooth, enabling real-time inventory refresh and synchronization with checkout systems. Although IoT improved connectivity and data transfer, it posed issues regarding network reliability, data security, and infrastructure expenses, which limited mass adoption [6].

In spite of all these developments, conventional shopping carts were still the choice because they were inexpensive and easy to use. Nevertheless, as customers increasingly demanded automation, a more advanced Smart Shopping Cart model came into being. This new version combines RFID technology with an Arduino Uno-based processor, blending RFID's effectiveness in detecting products with weight sensors for instant confirmation. The system automates billing, removes checkout queues, and enhances stock tracking, making it a functional and expandable solution for today's retail settings.

III. PROPOSED SYSTEM DESIGN

The smart shopping cart system that is envisaged utilizes RFID technology alongside an Arduino microcontroller to create a convenient and seamless shopping experience. The onboard RFID reader scans marked products in real time, making it unnecessary for a barcode to be scanned, and allowing the inventory to refresh in real time. The dynamic tracking system maintains an up-to-date digital record of products through the shopping path.

Microcontroller processes RFID and weight sensor data to verify for additions or removals of products. Built-in display provides customers real-time bill updates, product details, and available promotions. The system further enhances working efficiency as it automatically interfaces with the store's inventory database, thus enhancing stock management and eradicating queuing waits at checkout.

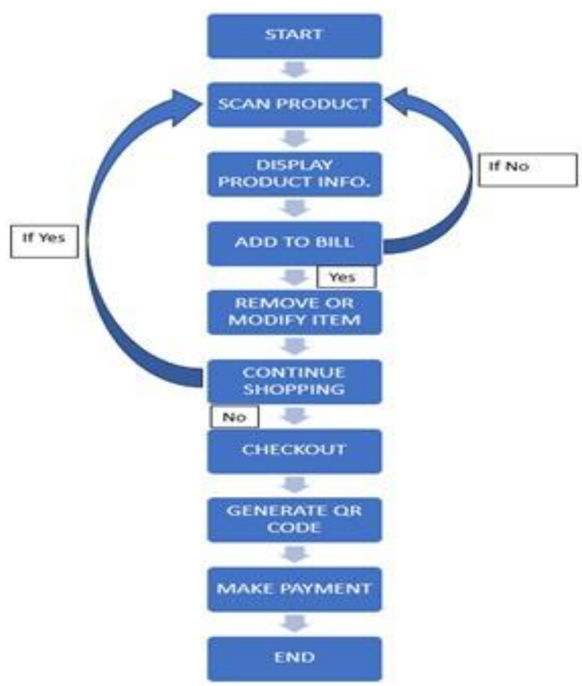

Fig 1: flowchart of proposed system design

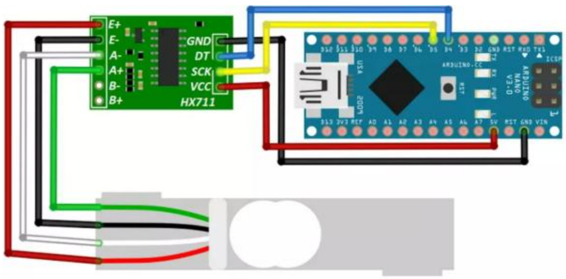

Fig 2: connecting Hx711 to load cell

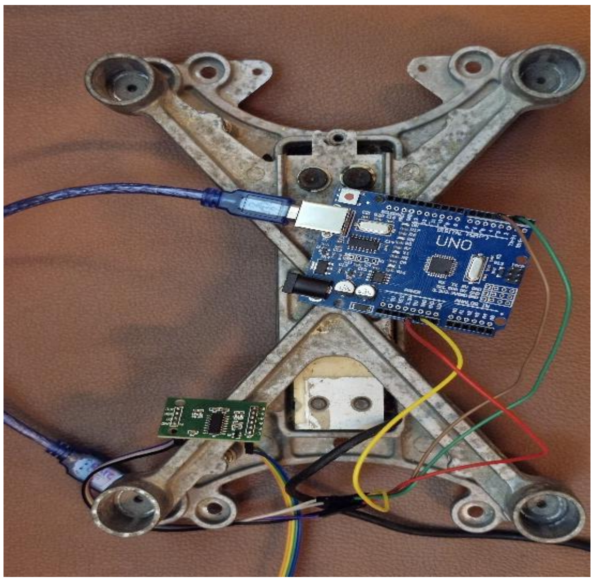

Fig 3: load cell connected to Arduino uno

IV. SYSTEM COMPONENTS

- RFID: The system makes use of passive RFID tags affixed to the products and an RFID reader attached to the shopping cart. Every tag has an EPC unique to it that matches the information about the product in a database. The RFID reader operates at the standard 13.56 MHz (HF) frequency band, offering a reliable read range of about 10cm, which is adequate for deliberate scanning actions by shoppers. RFID Reader Module (MFRC522) operates at 13.56 MHz with SPI interface, RFID Tags passive 13.56 MHz tags attached to products. RFID Module also handles tag reading, data parsing, and product identification.
- Processing Unit: An Arduino Uno serves as the central processing unit of the system, receiving input from the RFID reader, processing the data through predefined algorithms, and controlling the display output. The Arduino's ATmega328P microcontroller offers sufficient processing capability for the required tasks while maintaining low power consumption, extending battery life.
- Display Interface: A TFT LCD display (typically 3.5" to 5") connected to the Arduino presents the user interface. The display shows Currently scanned products, Running total amount, Product information (name, price, amount), Optional special promotion information or in-store browsing. LCD TFT Display (3.5" or larger): With SPI or I2C interface for product information display
- Power Management: The system employs a rechargeable lithium-ion battery pack that powers all electronic components. Charging stations at cart storage areas ensure carts are always ready for use. Power optimization techniques in the Arduino code extend operational time between charges. It also monitors battery levels and implements power-saving features
- Communication Module: An optional Wi-Fi module (ESP8266) enables real-time connection with the store's inventory management system, allowing for price updates, stock availability checks, and promotional offers based on shopping history.

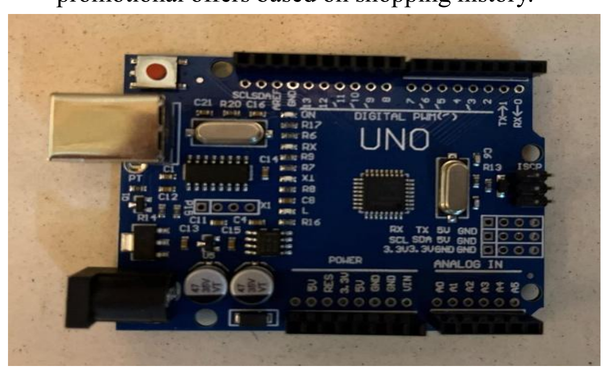

Fig 4: Arduino uno board

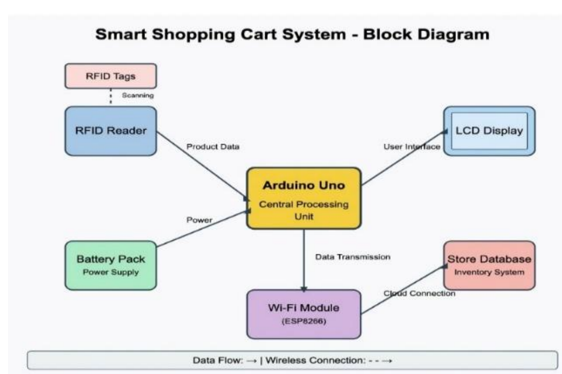

Fig 5: block diagram of system components

V. SYSTEM INTEGRATION AND FUNCTIONING

The smart shopping cart system combines RFID technology with an Arduino-based microcontroller system to mechanize the shopping process. The system includes an Arduino Uno, RFID reader, weight sensors, and an LCD display, all in a concerted effort to simplify product identification and billing.

When an item is placed in the cart, the RFID reader picks up the product's identification tag and adjusts the cart's inventory digitally. The Arduino computes the information, determining the overall price in real time. Weight sensors are another level of confirmation, checking whether the tagged item equals its predicted weight. When errors are detected, the system alerts the user to confirm the item.

A dedicated LCD display indicates running total, itemized receipt, and product information, providing clarity during shopping. In comparison with conventional barcode reading, there are no manual scan errors, and the check process is quick. After completion of shopping, a final bill is printed out and can be settled directly on the checkout desk, minimizing use of cashier-led billing.

This deployment balances efficiency and accuracy with simplicity and affordability, a practical solution for contemporary retailing environments.

VI. RESULTS

In this proposed work, a fully automated billing system is presented to enhance the shopping experience by eliminating manual barcode scanning. A system interface is presented using an intuitive display that provides real-time billing information as items are added or removed from the cart. The integration of load cell sensors and an Arduino-based processing unit ensures accurate weight detection and seamless price calculation. Experimental results demonstrate the system's ability to efficiently track products, generate precise billing, and reduce checkout time significantly. Additionally, the automated inventory management feature enhances retail operations by maintaining an updated stock record. The findings indicate that this system successfully improves accuracy, efficiency, and customer convenience in the shopping process.

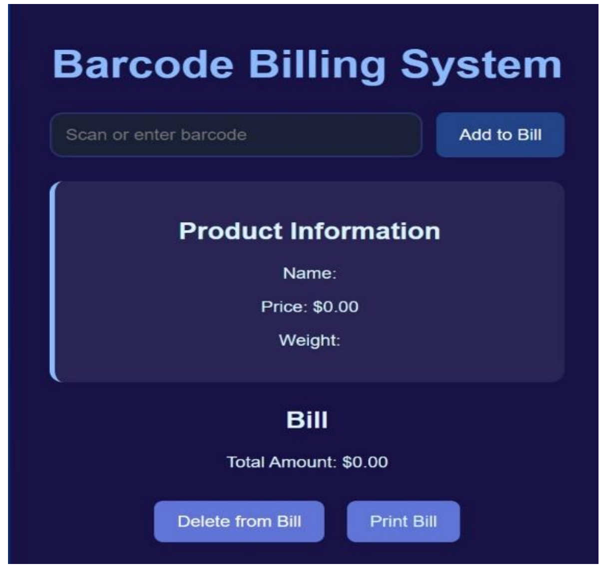

Fig 6: user interface of the barcode billing system

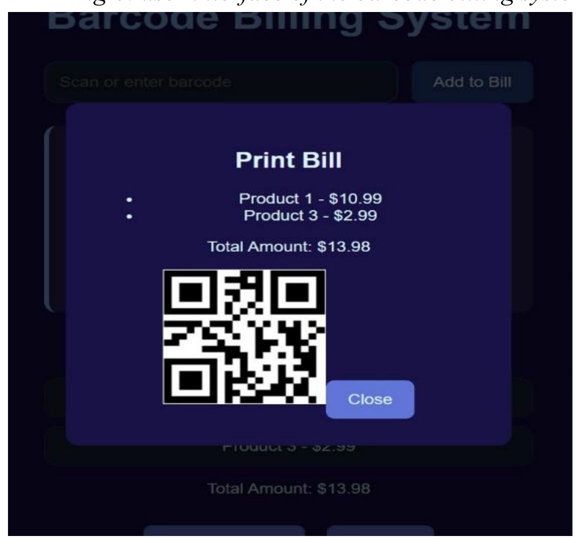

Fig 7: user interface showing the bill

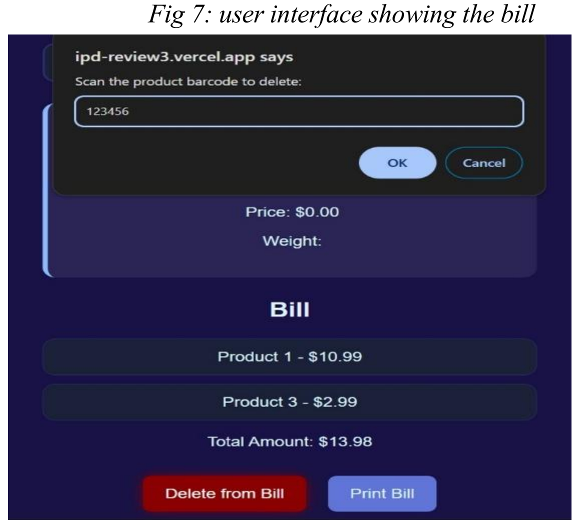

Fig 8: user interface showing product deletion

VII. SOCIAL IMPACT AND FUTURE

The Smart Shopping Cart improves the shopping experience by automating tasks and increasing convenience. In retail stores, it uses RFID technology to speed up billing, reducing checkout lines and enhancing customer satisfaction. Shoppers can view real-time product details, and cashless payments through QR codes make transactions faster and easier.

Supermarkets benefit from automated inventory tracking, preventing stock shortages and ensuring accurate records. The cart also offers personalized product suggestions and reduces manual work, lowering costs. In airport duty-free shops, it enables fast checkouts and supports multi-currency payments for travellers' convenience. Healthcare stores gain from precise billing and automated stock updates, ensuring essential supplies are always available.

VIII. CONCLUSION

The Smart Shopping Cart system offers a modern solution to the limitations of traditional barcode-based billing by combining an Arduino-based processing unit with load cell sensors. This system monitors item weight in real-time, cross-references it with a preloaded product database, and automatically generates a bill displayed on a user-friendly interface. By removing the need for manual barcode scanning, it minimizes human error, improves billing accuracy, and accelerates the checkout process. Customers benefit from quicker, more convenient self-checkouts, while retailers gain improved inventory accuracy through automatic product tracking. The system's adaptable design also allows for future upgrades, such as integrating contactless payment methods or real-time cloud storage, further enhancing efficiency. With its potential to redefine retail practices, the Smart Shopping Cart provides a practical and scalable approach to improving customer convenience and optimizing store operations.

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REFERENCE

[1] Al-Hakmani, A. K. S., & Sajan, A. (2020). Design and implementation of a smart shopping trolley using RFID technology. Journal of Student Research.

[2] Pandey, S., Gupta, S. R., Shaikh, M., Rawat, K. M. S., Jangid, P., & Mishra, R. (2018). Smart cart using Arduino and RFID.

[3] Vasanthakumar, R., Shiva, P., Priyadharsan, S., & Aravindhan, A. (2023). RFID-based smart trolley for automatic billing system. International Journal for Multidisciplinary Research.

[4] Raajha, D., & Kurankar, A. (2020). RFID-based smart trolley. International Journal of Engineering Applied Sciences and Technology.

[5] IoT-based smart shopping cart using radio frequency identification. (2020). IEEE. ISBN: 68427.

[6] Sarman, K. V. S. H. G., A, K., Ch, S. N. V. B., E, P., Ch, S. D., & A, V. S. S. (2024). Automatic smart shopping basket based on IoT applications. World Conference on Communication & Computing (WCONF).