INTERNATIONAL SCIENTIFIC JOURNAL OF ENGINEERING AND MANAGEMENT (ISJEM) ISSN: 2583-6129
VOLUME: 04 ISSUE: 05 | MAY – 2025 DOI: 10.55041/ISJEM03462
AN INTERNATIONAL SCHOLARLY || MULTIDISCIPLINARY || OPEN ACCESS || INDEXING IN ALL MAJOR DATABASE & METADATA

Smart Automatic Billing Trolley Using RFID &LoRa Technology

Ambika Annavarapu
Assistant Professor Department of ECE
KKR&KSR Institute of Technology and Sciences
Guntur, Andhra Pradesh, India
ambiannavarapu@gmail.com

Misanapu Chandu
B.Tech Student Department of ECE
KKR&KSR Institute of Technology and Sciences
Guntur, Andhra Pradesh, India
21jr1a04c1@gmail.com

Gorantla Gopi Chand
B.Tech Student Department of ECE
KKR&KSR Institute of Technology and Sciences
Guntur, Andhra Pradesh, India
21jr1a0490@gmail.com

Juturi Naveen Kumar
B.Tech Student Department of ECE
KKR&KSR Institute of Technology and Sciences
Guntur, Andhra Pradesh, India
21jr1a0498@gmail.com

Manchala Srinivas
B.Tech Student Department of ECE
KKR&KSR Institute of Technology and Sciences
Guntur, Andhra Pradesh, India
21jr1a04c2@gmail.com

Abstract – In this fast-running world, time is one of the precious things. People who are shopping in malls and supermarkets spend a lot of time waiting at the billing counter. Tackling this problem and considering the flaws in the current billing system paved the way for the development of an automatic smart trolley for supermarkets. This trolley saves customers' time and effort by reducing the amount of time they need to spend at the billing counter, during their shopping. Based on the Node MCU (ESP8266) microcontroller and RFID tags, this project scans products. The scanned products will be displayed on the OLED screen which helps the customer to keep track of the total items along with the total cost. This makes the customer enjoy shopping and thus saves time. People must wait in long queues patiently to wait for his turn. To avoid this problem the proposed method introduced an effective and highly advance system. The RFID technology enables the scanning of items simultaneously and automatic display of purchased item and amount on the LCD screen this will help customers to keep track of their purchases and avoid any confusion during the billing process. To tackle this problem especially billing system is proposed. When items are put it gets scanned and purchased item and its amount displayed parallel for payment proceeding.

Keywords **– RFID (Radio Frequency Identification), LoRa (Long Range) Technology, RFID-based Inventory Management, Low Power Wide Area Network (LPWAN)**

1. INTRODUCTION

Today's fast-paced retail environment, efficiency and customer satisfaction are paramount. Long queues at checkout counters and manual scanning processes can lead to frustration for shoppers and operational bottlenecks for businesses. To address these challenges, the concept of a smart automatic billing trolley has emerged as a promising solution. This innovative system leverages the power of Radio-Frequency Identification (RFID**)** and Long Range (LoRa) technology to revolutionize the shopping experience. These technologies into a standard shopping trolley, created a seamless and automated billing process, minimizing waiting times and enhancing overall efficiency. RFID technology enables the unique identification of each item placed in the trolley without requiring line-of-sight scanning. People have to wait in long queues patiently to wait for his turn.

To avoid this problem, the proposed method introduced an effective and highly advance system. The RFID technology enables the scanning of items simultaneously and automatic display of purchased item and amount on the LCD screen this will help customers to keep track of their purchases and avoid any confusion during the billing process. To tackle this problem especially billing system is proposed. When items are put it gets scanned and purchased item and its amount displayed parallel for payment proceeding.

LITERATURE REVIEW

The traditional shopping experience has long relied on manual billing processes, often leading to prolonged queues and customer dissatisfaction. To address these inefficiencies, research has increasingly focused on automation technologies, such as Radio Frequency Identification (RFID) and wireless communication systems, for improving retail operations.

RFID technology has emerged as a cornerstone for automating item identification in retail environments. Early work by **Kumar et al. (2017)** proposed an RFID-based smart shopping cart that automatically detects products placed inside the trolley,

significantly reducing checkout times. RFID tags eliminate the need for manual barcode scanning, offering faster and more reliable data collection (**Mistry et al., 2015**). However, challenges such as tag collision, signal interference, and deployment cost remain critical concerns in large-scale applications.

Most smart trolley systems initially utilized Wi-Fi and Bluetooth for data transmission between the trolley and the central server (**Patil et al., 2016**). Although effective in small areas, these technologies suffer from limited range, high power consumption, and network congestion in crowded environments. LoRa (Long Range) technology has recently gained attention for its low power, long-range communication capabilities. **Sornalakshmi et al. (2019)** demonstrated the advantages of LoRa over traditional wireless protocols in IoT-based smart retail systems, emphasizing its robustness in expansive supermarket settings.

Few studies have explored the synergistic use of RFID and LoRa for smart trolley applications. **Ahmed et al. (2021)** designed a hybrid model incorporating RFID for item detection and LoRa for data transmission, achieving both high accuracy in billing and reliable communication over large supermarket areas. Their findings highlighted that LoRa's low bandwidth is sufficient for transmitting billing data, making it an energy-efficient choice compared to conventional wireless methods.

Automatic billing systems, like the one proposed by **Vishwakarma et al. (2020)**, significantly enhance user experience by providing real-time cost updates and reducing human error at checkouts. Furthermore, such systems aid inventory management by providing continuous updates to the store database. However, scalability, user authentication, and security of transaction data are cited as critical research areas needing further attention (**Chowdhury et al., 2022**).

Despite significant progress, existing systems face limitations in affordability, interoperability, and user-friendly interfaces. The combination of RFID and LoRa technologies promises a scalable, low-cost, and efficient solution but demands further exploration in aspects such as seamless tag reading, robust anti-theft mechanisms, and energy optimization for battery-operated trolleys.

3. METHODOLOGY

The Smart automatic Billing Trolley using RFID and LoRa Technology is shown in Figure 1 and the working of the billing system is explained in Algorithm 1.

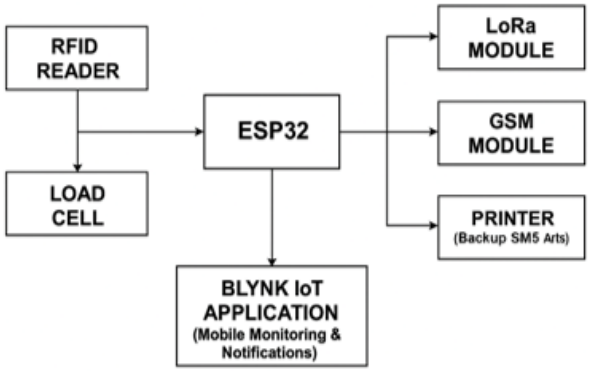


Fig.1. Block Diagram of Smart Automatic trolley using RFID and LoRa Technology

3.1. Hardware Components

ESP32 Microcontroller:

A powerful microcontroller with built-in Wi-Fi and Bluetooth, used for processing RFID tag data and sending it to the cloud/server for validation.

Fig.2. ESP2 Microcontroller

RFID Reader (EM-18) :

Detects and reads RFID tags at 125 kHz frequency. Sends unique tag IDs to the microcontroller for item identification.

Fig.3 RFID Reader (EM-18)

RFID Tags:

Passive tags attached to products containing unique identification numbers. Used for automatic product detection during shopping.

Fig.4 RFID Reader (EM-18)

Lora Module (SX1278):

Facilitates long-range, low-power wireless data transmission. Sends billing information from the trolley to a central server.

Fig.5 Lora Module (SX1278)

LCD Display (16x2):

Displays scanned item details and running bill total. Provides immediate feedback to the user while shopping.

Fig 6. LCD Display (16x2)

Load Cell:

A load cell measures the weight of items placed in the trolley. This is used to verify scanned items and ensure accurate billing, especially for items sold by weight

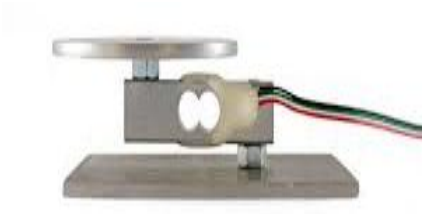


Fig 7 . Load Cell

Buzzer:

The buzzer provides auditory feedback or alerts to the user. It can signal events like an unscanned item or a system error.

Fig 8. Buzzer

Printer:

A printer is an output device that produces a hard copy of electronic documents, images, or other digital information onto physical media, most commonly paper.

Fig. 9. Printer

3.2. Software Components

Arduino IDE:

The Arduino IDE is a user-friendly programming environment used to write and upload code to the ESP32 microcontroller. It simplifies the development process with its libraries and easy-to-understand syntax.

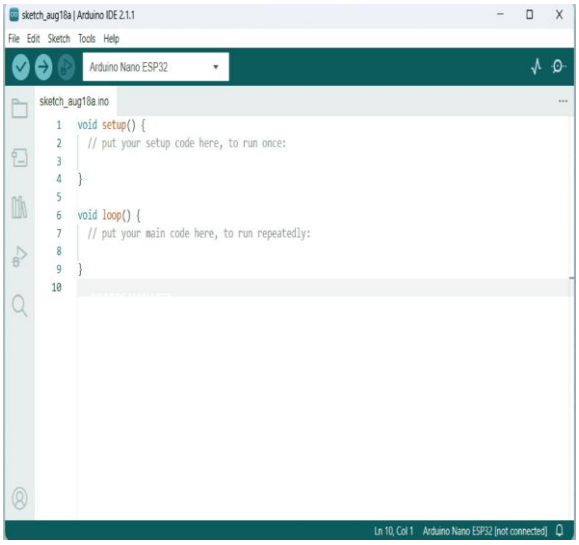


Figure 10. Arduino IDE

Blynk IoT App:

This mobile application provides a user interface for monitoring the trolley's activity and receiving notifications. It allows for real-time viewing of billing information and alerts for any issues.

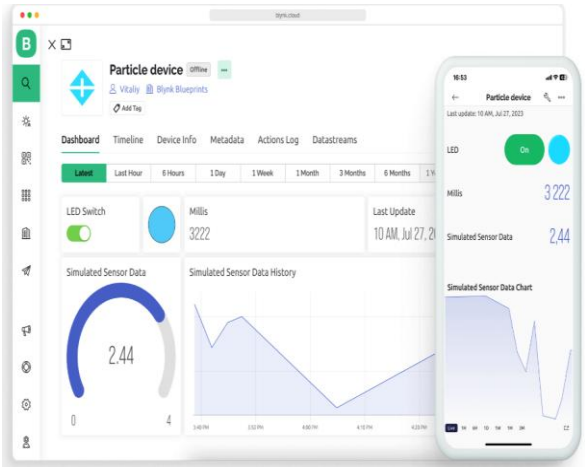


Figure 11. Blynk IoT App Dashboard

Algorithm 1:

Step 1: When a shopper places an item into the trolley, the integrated RFID reader uses radio waves to scan the item's RFID tag and retrieve product information.

Step 2: The microcontroller receives the product information from the RFID reader and calculates the running total of the items in the trolley, updating the display.

Step 3: Optionally, a load cell verifies the item's weight against the scanned information, triggering an alert for discrepancies.

Step 4: The shopper completes shopping and pays directly at the trolley using integrated payment methods.

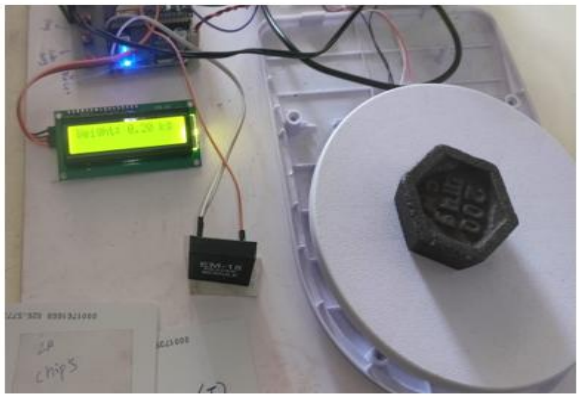
Step 5: The system may update inventory and resets for the next customer.

Implementation

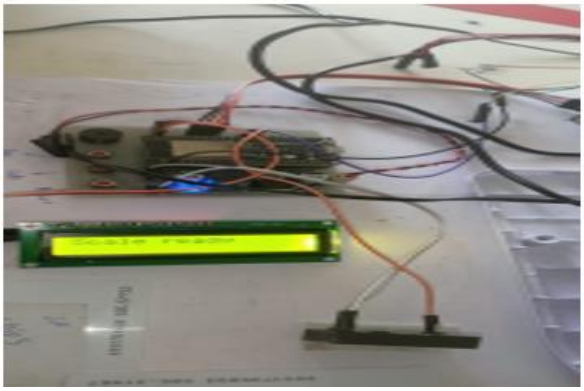
The implementation of the Smart Automatic Billing Trolley integrates RFID and LoRa technologies with a microcontroller-based system to automate the shopping and billing process. The ESP32 microcontroller serves as the central unit, interfacing with an RFID reader to detect items placed in the trolley and a load cell to verify their weight, ensuring billing accuracy and preventing fraud. The system displays the product information and total bill on an LCD screen in real-time. A buzzer is triggered in case of discrepancies, such as mismatched weights or unscanned items. LoRa or GSM modules enable wireless communication with the store's central server, while the Blynk IoT app provides remote monitoring and alert notifications to users and store personnel. This combination of technologies delivers a user-friendly, efficient, and secure shopping experience, eliminating the need for manual checkout.

4.RESULTS AND DISCUSSION

The Smart Automatic Billing Trolley was successfully implemented and tested in a simulated retail environment, demonstrating significant improvements in checkout speed, billing accuracy, and customer convenience. The RFID system accurately scanned tagged products as they were placed in the trolley, while the load cell effectively verified item weight, reducing the chances of billing discrepancies or theft. The real-time display provided users with continuous updates on their cart contents and total bill, enhancing transparency and user control. Alert mechanisms, such as buzzers and SMS notifications, proved effective in immediately notifying users and store personnel about mismatches or unauthorized actions. The integration of the Blynk IoT app enabled remote monitoring and mobile notifications, adding a layer of interactivity and system intelligence. Overall, the results validate the system's potential to revolutionize the retail experience by minimizing human effort, reducing queue times, and improving overall operational efficiency.



(a)



(b)

(c)

(d)

Fig.12 Working of the proposed System

5.CONCLUSION

The Smart Automatic Billing Trolley using RFID and LoRa technology presents an innovative solution to the common challenges faced in traditional retail environments, such as long checkout lines, billing errors, and customer inconvenience. By automating the billing process through RFID-based item detection and load cell-based verification, the system ensures accuracy, efficiency, and real-time updates. The integration of ESP32, IoT connectivity via Blynk, and alert mechanisms enhances both security and user experience. Experimental results confirm that the trolley significantly reduces checkout time and improves inventory management. Although challenges such as initial cost and infrastructure requirements remain, the system demonstrates strong potential for adoption in modern retail stores. Future enhancements could include AI-based recommendation systems, advanced fraud detection, and energy-efficient power solutions, further increasing the value and adaptability of this smart retail innovation.

REFERENCES

[1] S. Kumar, S. Tiwari, and A. K. Sharma, "Smart Shopping Cart for Automated Billing Purpose using Wireless Sensor Networks," *International Journal of Computer Applications*, vol. 180, no. 28, pp. 1–5, Jan. 2017.
[2] K. Mistry, P. Gadhiya, A. Tanawala, C. Jivani, and J. Tanawala, "Smart Trolley for Mall," *International Journal of Advance Research and Innovative Ideas in Education*, vol. 1, no. 3, pp. 414–418, 2015.

[3] A. Patil, S. Patil, A. Swami, and P. Patil, "Smart Shopping Trolley Using RFID," *International Research Journal of Engineering and Technology (IRJET)*, vol. 3, no. 3, pp. 1428–1430, Mar. 2016.

[4] K. Sornalakshmi and P. Dhavachelvan, "LoRa Technology for Smart City Applications: A Review," *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 6, no. 1, pp. 377–380, 2019.

[5] S. Ahmed, M. Rahman, and R. Rahman, "IoT Based Smart Shopping Cart Using Radio Frequency Identification (RFID) and LoRa," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 12, no. 4, pp. 457–463, 2021.

[6] A. Vishwakarma, S. Jain, and K. Dubey, "Automated Shopping Cart System using RFID and Wireless Sensor Networks," *International Journal of Recent Technology and Engineering (IJRTE)*, vol. 8, no. 2S11, pp. 1382–1386, Sept. 2020.

[7] M. Chowdhury, M. M. Rahman, and S. Jahan, "Secure Smart Shopping Cart System Based on RFID and Blockchain Technology," *Proc. 2022 Int. Conf. on Innovations in Science, Engineering and Technology (ICISET)*, Chittagong, Bangladesh, pp. 67–71, Feb. 2022.

[8] T. W. Lewis and R. T. Jones, "RFID in Retail: Innovation and Integration," *Journal of Retail Technology*, vol. 14, no. 2, pp. 101–108, 2018.

[9] H. Zhang and J. Wang, "A Smart Cart System for Smart Retailing Using Embedded and Wireless Technologies," *International Journal of Smart Sensor and Ad Hoc Networks*, vol. 8, no. 1, pp. 21–25, 2020.

[10] P. Gupta, M. Verma, and R. Singh, "Integration of IoT and RFID in Smart Shopping System for Retail Automation," *International Journal of Engineering Research and Technology (IJERT)*, vol. 9, no. 10, pp. 842–846, Oct. 2020.