IoT-Enabled Smart Shopping Cart with Embedded Systems for Social Distancing

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***Abstract*—People of all ages are becoming more and more drawn to electronic devices as a result of the radical changes in technology. Electronic equipment like RFID scanners, barcodes, and smart card readers are being used more and more in numerous businesses. These devices are also necessary for supermarkets. At the moment, every customer in the mall buys the item that is in the cart. The customer will have to wait in queue to be billed after making a transaction. An employee scans the barcode of each product and bills it to the final during the billing process. This procedure may take a long time, and it may be particularly arduous on weekends, holidays, or during special deals. A clever method of mall shopping has been devised to get around this. Every item is equipped with an RFID tag.**

Keywords—Automated billing, Radio frequency identification, Radio frequency identification readers, Smart shopping system, Trolley system.

I. INTRODUCTION

While shopping is simple, standing in queue at the billing counter can be tedious and time-consuming. When using a barcode scanner to compile a bill, Rush Plus cashiers take longer and provide results that stay longer. An automatic billing system that fits in a shopping cart is part of this creative idea. Rather than using conventional barcode scanners, this automated payment system has an RFID reader that is controlled by Arduino. Every customer receives a unique membership card that contains all of their personal information as well as account balance facts. Before shopping, customers can recharge, their balance and other information will be updated. Thus, the customer must always scan their unique membership card against the RFID scanner that is affixed to the shopping cart.

There are currently several options to address the previously identified problems, but performance evaluation still considers progress. Modern problem-solving strategies might set up a customer communication counter to help the consumer if a product inside the department store is a worry. This might be done by using barcode scanning technology in the pay register, where the price is saved in the barcode. This takes the role of the traditional approach, which involves manually entering each item in the mall one at a time. The technology in malls needs to be updated frequently to meet customer expectations. Should RFID technology eventually be implemented in shopping centres, the above listed issues may be enhanced or resolved. In an attempt to address this, this study suggests an RFID-enabled smart trolley.

II. LITERATURE SURVEY

[1] "IoT applications on secure smart shopping system". The objective of this paper include Designing a Smart Shopping System, Implement UHF RFID Technology, Ensure Security.System Design, UHF RFID Technology Implementation.

Pros: Improved Shopping Experience, Efficient Inventory Tracking, Low Power Consumption.

Cons: Implementation Costs, Technological Limitations, User Acceptance.

[2] "IoT-Based Automated and Contactless Shopping Cart During Pandemic Diseases Outbreak". The main objectives include Contactless Shopping, Reduced Queues, Budget Management.

Approach/Algorithm/Framework: RFID Integration, Member Card Management, IoT Integration

Pros: Minimized Virus Spread, Efficiency, Budget Control.

Cons: Security Concerns, Technology Dependence.

[3] Enabling and emerging technologies for social distancing: a comprehensive survey and open problems.The objective of this paper is to present a comprehensive survey on the role of emerging technologies in enabling, encouraging, and enforcing social distancing practices. Approach/Algorithm/Framework: Enabling Wireless Technologies, IoT Integration

Pros: Efficiency, Effectiveness.

Cons: Implementation Challenges, Privacy Concerns.

[4]"Wireless Technologies for Social Distancing in the Time of COVID-19: Literature Review, Open Issues, and Limitations".

The objective of this paper is to present a comprehensive survey on the role of emerging technologies in enabling,

encouraging, and enforcing social distancing practices. Approach/Algorithm/Framework: The research employs a systematic approach to collecting and filtering relevant articles within a ten-year span (2011-2021) from databases.

Pros: Comprehensive Review.

Cons: Technology-Specific Focus.

[5]"IoT-based smart shopping cart using radio frequency identification". The objective of the proposed IoT-based Smart Shopping Cart system is to enhance the shopping experience by leveraging RFID technology and IoT concepts.

Approach/Algorithm/Framework: RFID Technology, Mobile Application, Arduino Microcontroller.

Pros: Inventory Control, Automated Billing.

Cons: Implementation Costs, Technical Challenges, Dependency on Technology.

III. PROPOSED SYSTEMS

The proposed system utilizes 125kHz RFID tags attached to products in a mall, with an EM-18 reader integrated into shopping trolleys. When customers select items, the RFID tags are scanned, displaying product details and costs on the trolley's LCD screen. Simultaneously, this data is transmitted to a central PC via Bluetooth. If a consumer wants to delete an item, rescanning it deducts the fee. Shopping concludes by pressing a button, displaying the final bill on the LCD. Payment is facilitated using pre-charged RFID cards containing customer IDs and balances, which can be scanned at the trolley. Transaction details are available via a Bluetooth Android app. The system operates through Arduino, with simulation software used for testing.

IV. METHODOLOGY

This content diagram, screenshot as shown in figure 1, will provide a visual overview of the key components and functionalities of your IoT-enabled smart shopping trolley using embedded systems. Microcontroller is the brain of the system, responsible for processing data from sensors and controlling actuators. It employs an RFID reader to identify and track things placed in the cart using RFID tags. Shows the shopping list, itemized bill, promotional offers, and other relevant information in LCD screen.

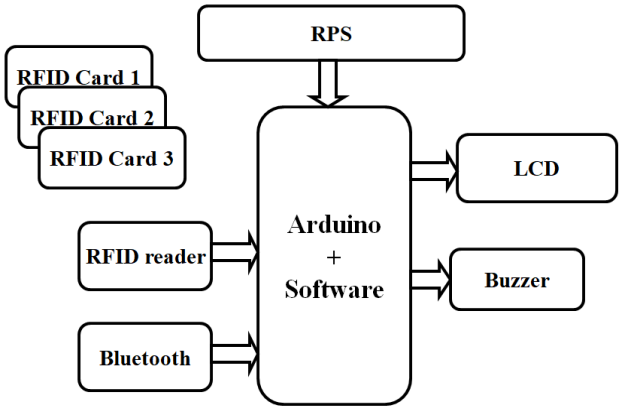


Fig. 1. Block diagram

Start: User begins shopping, screenshot as shown in figure 2.

- Scan Item: User scans items using the RFID reader.

- Add to Cart: Microcontroller adds the item to the cart.

- Check Total: User checks the total cost on the LCD screen.

- Proceed to Checkout: User decides to proceed to checkout.

- Connect to Wi-Fi: Cart connects to the internet using the ESP32

module.

- Send Data: Cart sends the list of items and their quantities to the

IoT Project Factory server.

End: User completes shopping.

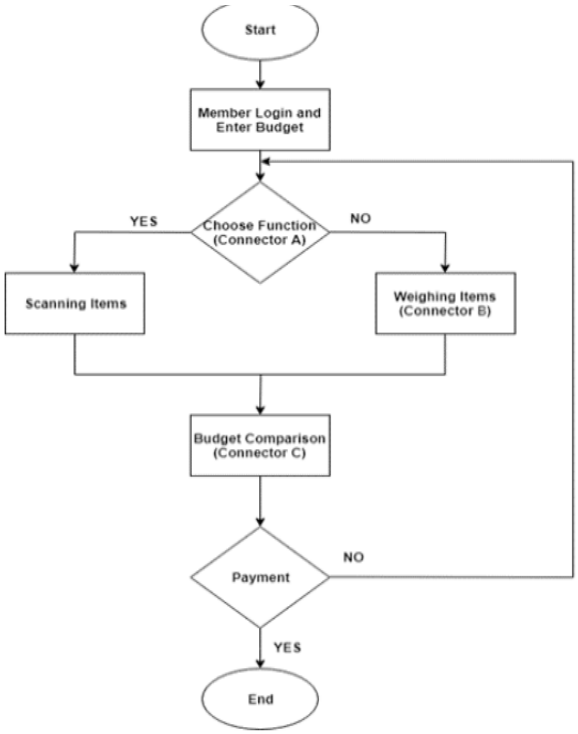


Fig. 2. System flowchart

V. USECASE DIAGRAM

Let's now look at the sequence diagram and use case diagramfor IoT enabled smart shopping cart with embedded systems for social distancing.

User: Interacts with the cart by scanning items and checking the total cost.

Cart: Receives item data from the RFID reader and updates the cart contents.

Wi-FiModule: Connects the cart to the internet.

IoT Project Factory Server: Receives data from the cart and processes it.

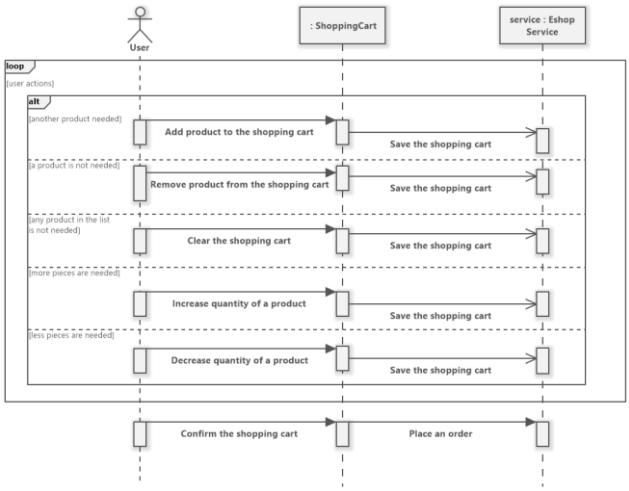


Fig. 3. Sequence diagram

- Scan Item: User scans an item using the RFID reader, screenshot as shown in figure 4.
- Add to Cart: Cart adds the scanned item to the shopping cart.
- View Total Cost: The user sees the entire cost of the products in their cart.
- Proceed to Checkout: User decides to proceed to checkout.
- Connect to Wi-Fi: Cart connects to the internet using the Wi-Fi module.
- Send Data to Server: Cart sends the list of items and their quantities to the server.

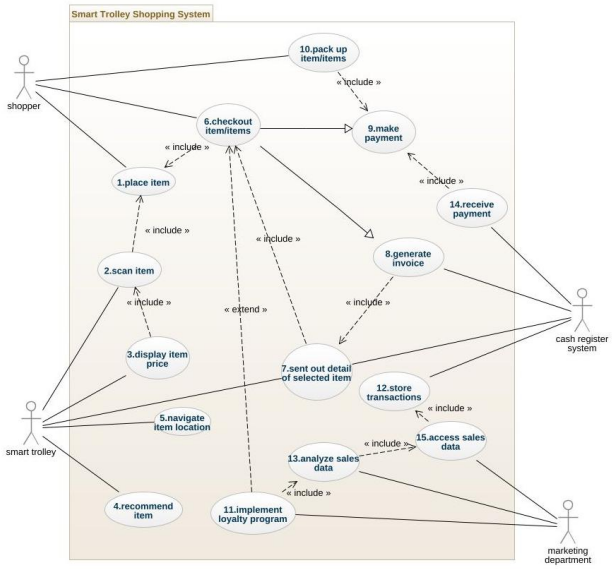


Fig. 4. Use case diagram

VI. RESULTS AND PERFORMANCE ANALYSIS

The system emits an audible beep to indicate an RFID tag has been scanned by the reader. The LCD displays a message like "Product 1 and cost", screenshot as shown in figure 5, to inform the user that the system is processing the scanned tag. The ESP32 module, likely connected to a database or local storage, identifies the product linked to the scanned RFID tag. he system calculates and displays the current total cost.

Fig. 5. Addition of product 1

The system acknowledges a scanned RFID tag with an audible beep. The LCD displays "Product name and cost" to inform the user that the system is processing the scanned tag. The ESP32 module, likely connected to a database or local storage, identifies the product linked to the scanned tag. If the scanned product is already present in the "cart", then it will remove the product from the total cost, screenshot as shown in figure 6.

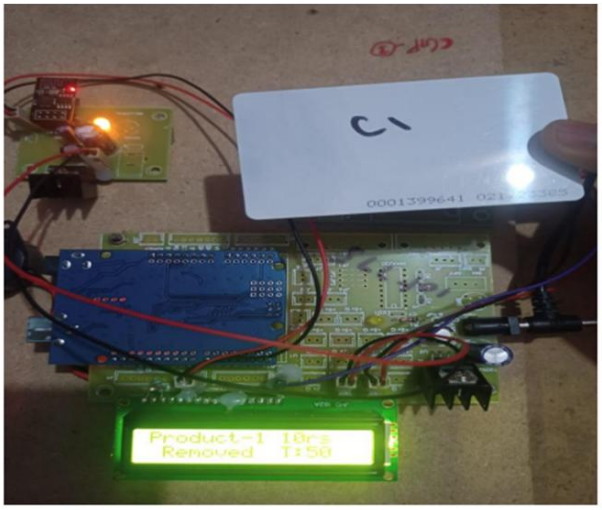
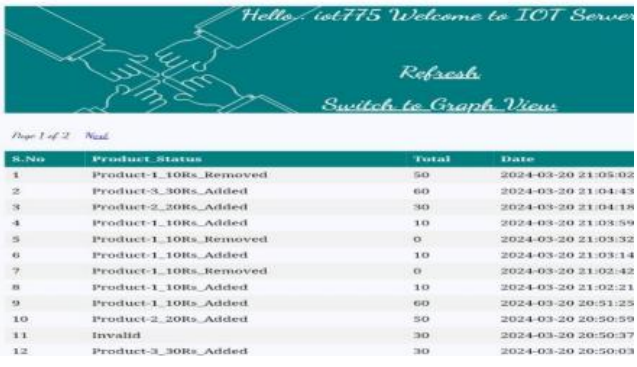


Fig. 6. Removal of product 1

The Esp32 module transmits the added, removed or expired product's details which consists of product's status, total cost and timestamp to the project factory server, screenshot as shown in figure 7.



S.No	Product_Status	Total	Date
1	Product-1_10Rs_Removed	50	2024-03-20 21:05:02
2	Product-3_30Rs_Added	60	2024-03-20 21:04:43
3	Product-2_20Rs_Added	30	2024-03-20 21:04:18
4	Product-1_10Rs_Added	10	2024-03-20 21:03:59
5	Product-1_10Rs_Removed	0	2024-03-20 21:03:32
6	Product-1_10Rs_Added	10	2024-03-20 21:03:14
7	Product-1_10Rs_Removed	0	2024-03-20 21:02:42
8	Product-1_10Rs_Added	10	2024-03-20 21:02:21
9	Product-1_10Rs_Added	60	2024-03-20 20:51:25
10	Product-2_20Rs_Added	50	2024-03-20 20:50:59
11	Invalid	30	2024-03-20 20:50:37
12	Product-3_30Rs_Added	30	2024-03-20 20:50:03

Fig. 7. . The Shopping bill

A. Result Analysis

Incorporating an automatic billing system into the embedded-based auto cart application enhances the shopping experience by streamlining the checkout process. Utilizing RFID technology or barcode scanners, the system can automatically identify and tally the items placed in the cart. As shoppers proceed through the store, the system continuously updates the virtual cart, keeping track of the selected items and their corresponding prices. Wireless data transfer capabilities enable seamless communication between the auto cart system and backend servers, facilitating real-time updates and data synchronization. Designing the auto cart system with efficiency and cost-effectiveness in mind involves optimizing hardware and software components to minimize resource utilization while maximizing performance. Minimizing power consumption is essential for prolonging battery life and ensuring uninterrupted operation of the auto cart system. Employing energy-efficient components, such as low-power microcontrollers and sensors, helps reduce power consumption during idle and active states.

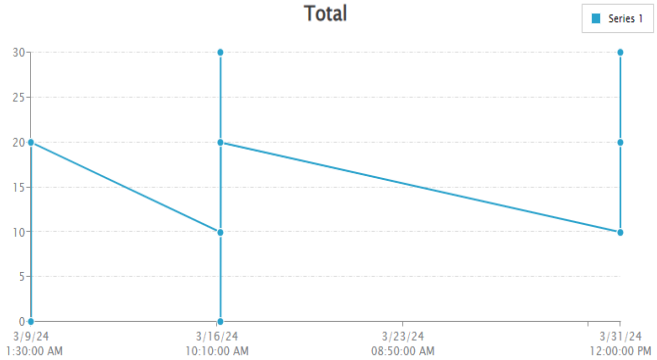


Fig. 8. Graph view

VII. CONCLUSION AND FUTURE WORK

The advancement of science and technology is an unstoppable process. Emerging technologies are created every now and then. The future, where technology may take over every space, is beyond our comprehension. Supermarkets, malls, and shopping centers are just a few locations where this creative project idea might be used to buy goods. Here, RFID cards are utilized to gain secure access to all products at retail establishments. All necessary product information will be shown on the LCD screen and in the Android Bluetooth app enabling a simple billing process at the counter if a product is scanned and added to the cart. As a result, to access the products, an RFID tag or card is required. Consequently, this project will aid in enhancing security and making purchasing more efficient. The development of embedded-based auto carts represents a significant advancement in automation technology with widespread applications across diverse industries. Throughout this project, we have explored the multifaceted potential of auto carts in various domains, ranging from healthcare and hospitality to security and entertainment. These applications have underscored the versatility and adaptability of auto carts in addressing unique challenges and enhancing operational efficiency across different sectors. As we continue to explore and refine the capabilities of auto carts, we envision a future where automation enhances efficiency, safety, and convenience across all aspects of human life.

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