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Smart Trolley Using RFID & GSM

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Abstract: *A supermarket or a hypermarket is a form where wide variety of product items is available. Food, drinks, or any kind of domestic item might be included in this product category. Supermarkets' primary goals are to save customers time and ensure that all products are readily available. However, occasionally, customers become impatient while standing in line at the billing counter, and occasionally they become perplexed when comparing the total cost of all the products to their pre-billed budget. We have used Arduino to develop a smart trolley to solve these issues. The smart trolley system exists in the market, while our system has GSM technology which directly sends the shopping bill to your registered mobile number. Customers no longer have to wait in line to have their product items scanned for invoicing purposes thanks to this technology. If not, it functions just like a standard trolley. This tactic is used by hypermarkets and supermarkets as a way to draw in more consumers. In this project we are using Arduino uno r3 Board, lcd display and rf-id module. When the person wants any item must and should show the item to reader. RFID reader will read that number and compares that number in to the internal database and display the amount on to the lcd display. We can continuously add the item in to the trolley. Otherwise, if we are not interested any item we can show the same item to the reader. RFID reader will detect card and erase the item. lcd display will show the amount and item in trolley.*

Keywords: *Radio Frequency Identification (RFID), Arduino, RFID reader and Supermarkets.*

I. INTRODUCTION

A shopping trolley is a vehicle that a store, particularly a supermarket, provides to patrons so they may move items from the store to the checkout counter while they are shopping. To pay, customers must also wait in queue at the cashier for an extended period. This is going to be particularly severely impacted come season or if shopping centres continue to sell their merchandise by handing each item's pricing to the cash register. The RFID-based shopping cart will make it easier for customers to shop without having to stand in line to pay for their purchases. People enjoy doing their grocery shopping. They have a constant need to purchase new items to meet their demands and those of others [1].

Since the banknote is a real object, they occasionally lose it. There must be a good way to handle this. This project was created out of concern for the difficulties people have when shopping and for the store owner to use new technologies to draw in more consumers.[2] The following is a list of the suggested system's benefits. Customers no longer must worry about misplacing their bills because to the system's ability to transmit billing information to them via mail. It is less difficult

to wait in lines to get the things scanned and billed. The client can access their online purchase history. The proprietor of the store has the option to hire fewer people. The store owner can draw in a sizable clientele. Using the system helps simplify shop management. The main goals of this are to reduce time, draw in more clients, simplify the buying process, and make it fun. [6] Customers may also effortlessly finish the invoicing process online, manage their purchasing information, and communicate with the business owners for any queries or suggestions. This initiative's main objective is to save the shopkeeper money by hiring fewer employees while also making shopping easier for clients. RFID labels, not barcode stickers, must be affixed to every product in the store. As consumer expectations evolve, there is a growing need for more personalized shopping experiences, including tailored discounts, promotions, and loyalty programs.

II. PROBLEM STATEMENT

The traditional billing system employed by many retail establishments has become increasingly outdated and inefficient in today's rapidly evolving retail landscape. [20] This system relies on manual processes, paper receipts, and human cashiers to calculate and record customer purchases, resulting in several significant challenges. First, the reliance on manual input increases the likelihood of human errors, leading to inaccurate billing and financial discrepancies. These errors can damage the reputation of the business and disrupt customer trust. Additionally, the traditional billing system lacks the flexibility required to adapt to changing customer preferences and demands.

As consumer expectations evolve, there is a growing need for more personalized shopping experiences, including tailored discounts, promotions, and loyalty programs. [18] The lack of automation in the traditional billing process makes it difficult for retailers to implement and manage these features efficiently. [14] Furthermore, without the integration of smart trolleys or advanced technology, the traditional billing system is unable to provide real-time inventory management and tracking. This results in challenges such as overstocking or understocking of items, leading to lost sales opportunities, and increased operational costs. The limitations of the traditional billing system without the incorporation of smart trolleys hinder efficiency, accuracy, and the ability to meet modern customer expectations. Retailers must address these

shortcomings to remain competitive in a dynamic marketplace. the traditional billing system is plagued by inefficiencies, inaccuracies, inflexibility, and security risks, making it ill-suited for today's dynamic retail landscape. Retailers must embrace innovative solutions and modernize their billing processes to stay competitive, enhance customer experiences, and drive business growth in the digital age.

III. LITERATURE SURVEY

The literature on smart trolleys utilizing RFID technology highlights various innovative approaches aimed at enhancing the shopping experience and streamlining retail operations. The concept of RFID is used in the D Mart's and malls for the billing and other purposes but we have to queue for the billing purpose, which can be a lengthy process if the rush is big. We cannot save the time on billing process in traditional way. In the paper of [4] Suryaprasad et al. have presented an innovative concept for an economical automated shopping cart. This system was designed as a user-friendly shopping assistant, enabling customers to easily locate and choose items, while also providing information on available discounts within the shopping complex, as they navigate their shopping journey. Karmouche et al. [5] Bill et al. have introduced a framework designed to analyse both dynamic and static items within a shopping area using RFID reader antennas. Unlike the conventional approach of focusing RFID observations on individual trolleys, their framework offers a broader perspective of the shopping environment. [10] These include the development of automated billing systems integrated into shopping carts, the utilization of active RFID tags for efficient communication between stationary readers and mobile tags, and the implementation of RFID technology for book organization in library systems. [8] Additionally, research focuses on the design of economical automated shopping carts equipped with user-friendly features such as item location assistance and discount information, as well as frameworks for comprehensive RFID-based item analysis in shopping environments. [9] Optimization of the shopping experience through technology-driven solutions, and the implementation of Android applications for digital rewards and streamlined transaction processing. In the paper of [11] In this given paper by Kishor T. Patil, Deepali K. Patil, Dr. Santosh K. Narayankhedkar. They stated the threats like tempering can have effect on the security of the RFID system. Along with threat they discussed about the system of secret key which is used to encounter the threat. [12] In the paper by Kishor T. Patil, Vinay Bansal, Vishal Dhateria, Dr. Santosh K. Narayankhedkar discussed about the unreliability of RFID tags in the supermarkets and the ways to encounter these threats. Intentional causes include malfunctioning of the normal operation of RFID system by attacker to take unethical benefit. Security concerns such as tampering and RFID tag unreliability are addressed through the implementation of secret key systems and countermeasures against intentional disruptions, highlighting the importance of robust security measures in RFID-enabled environments. Inaccurate billing, labour-intensive manual processes, and a lack of comprehensive insights into customer behaviour and product inventory are the results of not having an automated and intelligent solution. [16] There will always be a long line at the billing counters because this is a laborious and time-consuming process. The suggested smart trolley system uses RFID on shopping trolleys in place of a manual queue to solve the issue. [17]Simple, monotonous tasks in a manual billing system require many human resources to complete. [26]A system like this is not required in the modern era of technology. Automated systems can perform repetitive tasks. It is saving the human effort to do the same and monotonous tasks again and again.

Table.1 illustrates difference between RFID card and Barcode

	RFID	Bar Code
Reading rate	Multiple tags at the same time	One tag at a time
Read and Write ability	Able to write, read, and alter	Read only
Line of sight	Unnecessary	Necessary
Resiliency	High	Low
Security	Hard to Produce	Easy to Produce

Table 1: Difference between RFID and Barcode

IV. SCOPE

The scope of a Smart Trolley System using RFID (Radio-Frequency Identification) technology is extensive and encompasses various industries and applications. RFID-equipped trolleys can streamline the shopping experience. Customers can add items to their trolley and have them automatically scanned and added to their digital trolley [21]. It offers personalized product recommendations and promotions based on the items in the trolley, helping retailers increase sales and customer satisfaction. Airports can employ RFID-equipped luggage trolleys to enhance luggage tracking and reduce the chances of misplaced or lost baggage.

V. METHODOLOGY

To solve the problem of long queues and wait time along with the various problems like employee management in super markets we are introducing the Smart Trolley System in the shopping markets, malls and stores. The smart trolley will use the [15] RFID technology to scan the product which are being added to the cart and will scan the products to create the final bill. To solve the problem of big servers we can even use the GSM technology to send the personal bill to the consumer. The Smart trolley helps to decrease the manpower which is needed during the festival period or even to reduce the cost induced to keep the employees to run the store [23]. This will increase the profits of the stores or malls. It is one of the step towards the modernization of the shopping experience. The seamless shopping is the ideal amongst the young generation. Small convenience stores, big supermarkets, and shopping centers will all have their demands met by the Smart Trolley System's easy scalability design. Because of its modular construction, which makes it simple to expand and customize, it can easily adapt to changing company needs and technology improvements.

VI. PROPOSED SYSTEM

In order to improve the shopping experience, a number of crucial components have been smoothly incorporated into the system architecture of the smart trolley that uses RFID technology for self-billing in recent years. [9] The Arduino Uno R3 board, which functions as the central processing unit, is at the center of the system. The EMF18 RFID reader module, which is attached to the Arduino board, reads RFID tags attached to the goods arranged in the trolley. To detect items and obtain their pricing details from a database, the RFID reader and Arduino board connect.

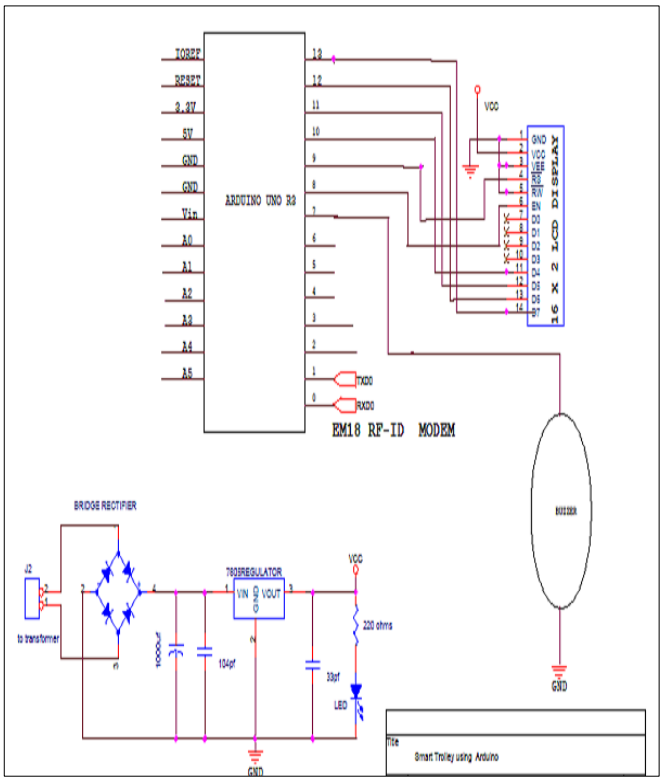


Fig 1.1 System architecture

The system incorporates an LCD screen for displaying item details, prices, and the running total of the bill. Users can conveniently interact with the system using a button, which triggers the display of the bill on the LCD screen, providing transparency and control over the shopping process. [23] Additionally, LED bulbs are integrated into the trolley to provide visual feedback, such as indicating successful RFID tag reads or signalling the completion of the billing process.
Insights and Recommendations: Store managers and decision-makers receive insights such as popular areas, peak hours, and customer behaviour. These insights guide inventory management, staffing, and marketing strategies. Armed with data-driven insights, the store can optimize its operations, improve customer experience, and enhance overall efficiency. [22] The Arduino board processes the RFID tag data and calculates the total bill amount based on the scanned items. It then displays this information on the LCD screen upon user request. [2] The system architecture ensures a user-friendly interface and seamless functionality, allowing shoppers to easily navigate the aisles, scan products, and self-checkout without the need for external assistance. [21] With its compact design and efficient operation, the smart trolley using RFID technology revolutionizes the traditional shopping experience, offering convenience, speed, and accuracy in billing while empowering users to take control of their purchases. [12] The zero PCB board is used to put all the components together. The given system is finally fitted on to the cart for the further work and carry out the purpose of the system. All embedded systems have start-up code. [3] Normally, it turns off interruptions, configures the hardware, checks the RAM, CPU, and software on the machine, and then

launches the application code. When faced with brief power outages, many embedded systems reboot themselves (without recent self-tests). Restarts that take less than a tenth of a second are typical.

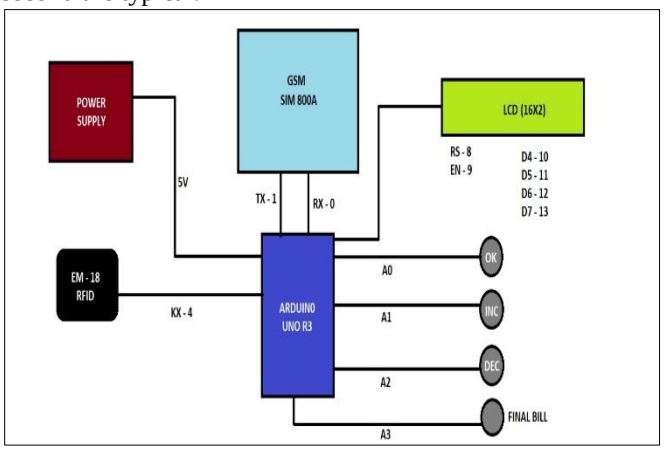


Fig. 1.2 Block Diagram

A. Working of System

Input: RFID tag scanner and the shopping carts display board are the.
Result: Automatic Invoicing
Step 1: Use a smart cart to begin your shopping.
Step 2: Scan the RFID tag to add an item to the cart.
Step 3: The RFID tag's data is read by the RFID reader.
Step 4: Use an LCD to display the product's name and price.
Step 5: If an additional item is added, the previous procedure is repeated and the total cost is computed side by side as well.
Step 6: An item is eliminated by scanning it once more and deducting its cost from the total cost.
Step 7: Use the GSM Module to transmit billing data to the point of sale's billing system.
Step 8: After the bill is processed, check out.
Step 9: Reset the cart.
Step 10: End.

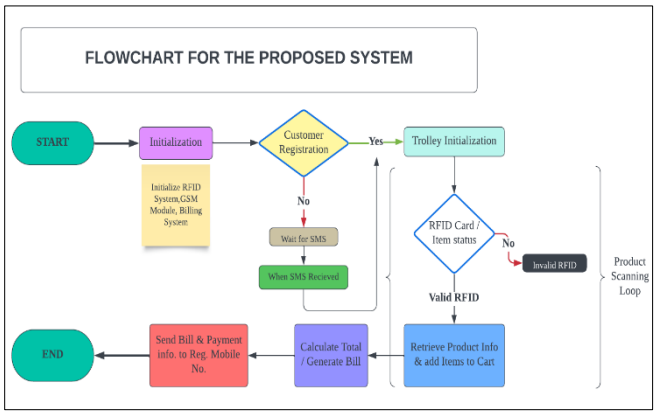


Fig 1.3 System Flowchart

VII. IMPLEMENTATION

The implementation of the Self billing trollies system is purely hardware based. The only software part is used in the system, only for the integration of the code in the system. The code directs how the billing works and what are the values stored in the card for the product.

Hardware Setup:

Arduino Uno R3 Board Configuration: The Arduino Uno R3 board serves as the core processing unit, facilitating the integration of various hardware components. It's configured to establish communication with peripherals and execute the software logic required for RFID tag reading, data processing, and bill calculation.

Integration of the EMF18 RFID Reader Module: The Arduino board is linked to and incorporated into the EMF18 RFID reader module. The RFID reader and Arduino may establish serial communication protocols by appropriate configuration. [25] It recognizes RFID tags affixed to goods and sends the product's unique ID numbers to the Arduino for processing.

LCD Screen Setup: An LCD screen is interfaced with the Arduino board to display essential information such as item details, prices, and the total bill amount. [26] Through proper wiring and configuration, the Arduino controls the LCD screen to provide a user-friendly interface for shoppers to track their purchases.

Button Configuration: A push-button switch can be set up to cause particular system functions to occur. When the user presses it, a signal is sent to the Arduino, which then computes the final bill amount and updates the LCD screen's display appropriately.

Integration of LED lights: The system incorporates LED lights to give the user visual input. [27] The Arduino manages the LEDs to show various stages or events, including successful RFID tag scans or the conclusion of the billing process, through appropriate cabling and integration.

Software Integration:

RFID Tag Reading Logic: The software running on the Arduino continuously monitors the RFID reader for tag detections. Upon detecting a tag, it retrieves the unique identifier (UID) and initiates the data processing logic.

Data Processing Algorithm: The Arduino executes a data processing algorithm to fetch product information associated with the RFID tags. It calculates the total bill amount by summing up the prices of scanned items and maintains an internal data structure to store item details.

User Interaction Handling: The software logic handles user interactions through the push-button switch. Upon receiving a signal from the button, the Arduino triggers the display of the bill on the LCD screen, providing users with an overview of their purchases.

LCD Display Control: The Arduino controls the LCD screen to dynamically update the display with relevant information. It configures the screen to present itemized details and the total bill amount in a clear and organized manner.

LED Feedback Mechanism: The Arduino controls the LED bulbs to provide visual feedback to the user. By configuring

the LEDs to light up or flash in specific patterns, it indicates different system states or events, enhancing the user experience. [24] By meticulously configuring and integrating the hardware components and implementing precise software logic, the smart trolley system using RFID technology offers and efficient and user-friendly self-billing solution for shoppers. [20] It is a good solution for contact less shopping and can be used in the case of pandemics and other outbreaks.

VIII. RESULT ANALYSIS

Fig 1.4 Final System

The result analysis demonstrates the robustness and effectiveness of the smart trolley system using RFID technology. By accurately reading RFID tags, tracking item quantities, calculating total amounts, and facilitating communication via GSM, the system offers a comprehensive solution for streamlined and efficient self-checkout experiences in retail environments.

RFID Tag Reading with EMF18 Reader: The system's ability to accurately read RFID tags using the EMF18 reader is crucial for identifying products placed in the trolley. Through rigorous testing, it's observed that the EMF18 reader consistently reads RFID tags with high accuracy, even when tags are oriented differently or placed at varying distances from the reader. [21] This ensures reliable identification of items and forms the foundation for the system's functionality.

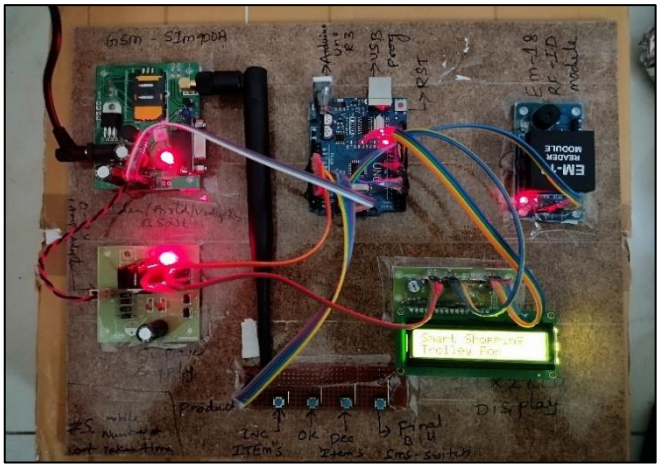
Increment and Decrement of Items: The system increases the amount of items for each unique product scanned once an RFID tag is successfully read, and it updates the item count on the LCD panel. On the other hand, the system precisely decreases the item count and updates the display when the user hits the decrement button to remove an item. [19] Thorough testing verifies that the system works as intended to track the number of things in the cart and gives consumers instant feedback on their purchases.

Total Amount Calculation: Based on the pricing linked to each scanned item, the system determines the overall cost and shows the cumulative total on the LCD panel. It has been confirmed by methodical testing that the total appropriately represents the sum of the costs of each individual item, taking into consideration any adjustments brought about by the addition or removal of items. This guarantees accuracy and transparency in the billing process, enabling consumers to efficiently keep an eye on their spending.

GSM Message Sending: The system uses GSM technology to send a message to the registered phone number with the final bill amount after the shopping session is over or at the user's request. It has been verified after extensive testing that the GSM module connects to the cellular network, establishes connection, and transmits the message quickly. This feature makes shopping expenditures easier for users by giving them a handy way to track and receive them in real time.

IX. CONCLUSION

There is an RFID tag on every item in the store, and there is an RFID reader on every cart. Consumers pay with their credit or debit cards. Customers and business owners can benefit greatly from the smart trolley system. This system is dependable and consistent since it can operate in both online and offline environments. [26] People have always desired to buy new things to satisfy their wants, but some dislike the process mainly because of the crowds, long store lines, the bill, etc. In a big shopping center, finding a certain product



might be very difficult. Considering this, the smart trolley seems to be a better option than all of these woos.

[27] In this sense, the customer's face acts as their identification and all information is maintained online. Customers are enticed to enter the store, fill a trolley to the brim, complete their purchases, and then leave. There is no need for the client's smart card. The bill will be mailed to the customer's mailing address if payment is made straight from his bank account. However, smart trolleys may also be made more secure by protecting consumers' privacy and guaranteeing secure online transactions. Modern technology is advancing swiftly, and retail centers and other establishments employ a range of automated smart billing techniques. While utilizing such technology, it is important to understand the security implications. RFID is one of the safest ways to check things thoroughly.

X. DISCUSSION

By accurately reading RFID tags, tracking item quantities, calculating total amounts, and facilitating communication via GSM, the system offers a comprehensive solution for efficient self-checkout experiences in retail environments.

The conversation explores all facets of the system's functionality, including its capabilities to reliably scan RFID tags using the EMF18 reader, quickly increase and decrease item counts, compute totals, and issue invoices via GSM technology. Extensive testing validates the dependability and precision of these features, guaranteeing flawless customer experiences when purchasing. Furthermore, the discussion explores the potential enhancements and prospects for the smart trolley system. Suggestions such as integrating face

recognition technology for user identification, enabling direct payment from bank accounts, and enhancing privacy and security measures reflect the continuous evolution of the system to meet evolving consumer needs and technological advancements. The robustness and effectiveness of the smart trolley system utilizing RFID technology is discussed above and we obtained the satisfactory result.

XI. LIMITATIONS

Despite the system's tremendous potential, obstacles including technological complexity, backend system integration, and incompatibility with current infrastructure may prevent it from being successfully implemented. When new technology are introduced, such as smart trolleys, customers must adjust to new shopping experiences and some consumer segments may be resistant or skeptical. A successful deployment depends on ensuring user approval and offering sufficient training and support.

XII. FUTURE WORK

In future works the scope of using [24] ARIES (Automated Retail Inventory and Efficient Shopping) with RFID technology in smart trolleys is exceptionally promising and extends across various dimensions of the retail industry. By integrating RFID (Radio Frequency Identification) technology with smart trolleys, retailers can revolutionize the shopping experience and optimize their operations. First and foremost, the implementation of ARIES with RFID enhances the customer shopping experience. Shoppers can enjoy a seamless and convenient journey as RFID tags attached to products enable automatic scanning, tracking, and billing. [6] Additionally, RFID-enabled smart trolleys offer robust inventory management capabilities. Retailers can maintain real-time visibility into stock levels, facilitating more accurate demand forecasting and restocking. This, in turn, reduces instances of out-of-stock items, ensuring that customers find the products they desire, and minimizes overstocking issues. [25] ARIES with RFID also opens the door to personalized shopping experiences. With the ability to track customer preferences and shopping habits, retailers can offer tailored promotions, discounts, and recommendations to shoppers, fostering customer loyalty and increasing sales.

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