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Dual-Mode Cart for Retail and Industrial Automation

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ABSTRACT—

Purchasing products has become a routine and mandatory task in today world. Billions of consumers go shopping every day in the world, particularly on the weekends and holidays when large crowds near shopping malls are observed. Currently, shopping is performed with the help of traditional carts. The billing process is time-consuming also tedious task to stand in the large queue and has created the need for shops to employ more human resource. Technology is evolving immensely in the world to simplify human lives. As IoT and AI are most advanced technologies in the present era, integrating these technologies in the field of shopping and purchasing products has turned out as an anticipated evolution in the market. The proposed system aims at designing a Smart Cart which simplifies the process of shopping effectively and efficiently. The main objective is to reduce the waiting time at billing counters in shopping marts.

Keywords—Shopping, Smart cart, Internet of Things, Arduino

I. INTRODUCTION

Shopping has been a part of human life for centuries, from traditional markets to modern shopping malls. However, with the growth of population and cities, the shopping experience has become increasingly challenging. In the past, shopping was a time-consuming process that required the physical presence of the buyer in the market. Buyers had to navigate through crowded marketplaces, haggle with sellers, and carry their purchases to their homes. In contrast, modern shopping malls offer a more convenient shopping experience, but there are limitations. Shopping malls can be vast, and finding the desired products can be a challenge. Additionally, physically challenged people, particularly the visually impaired, face many difficulties when shopping.

Cities often get very crowded during festival weeks and weekends. There is an increase in people shopping at stores offering big discounts and rewards. Supermarkets aim to offer a wide range of products to customers in order to save them precious time. Before paying for their purchases, customers might find it hard to determine if they are staying within their budget. For handling these problems, we have put together a passive and affordable shopping cart using Arduino. An LCD screen and a QR scanner are features of the trolley to make sure all the controls are working. Whenever we place an object on the scanner, the QR code is detected instantly. Supermarkets aim to help clients save time by making all merchandise available to them. We invented a shopping cart that uses Arduino and works by attaching an LCD display and a QR scanner to the trolley. As soon as an object is placed, the QR Scanner detects any QR code on the merchandise.

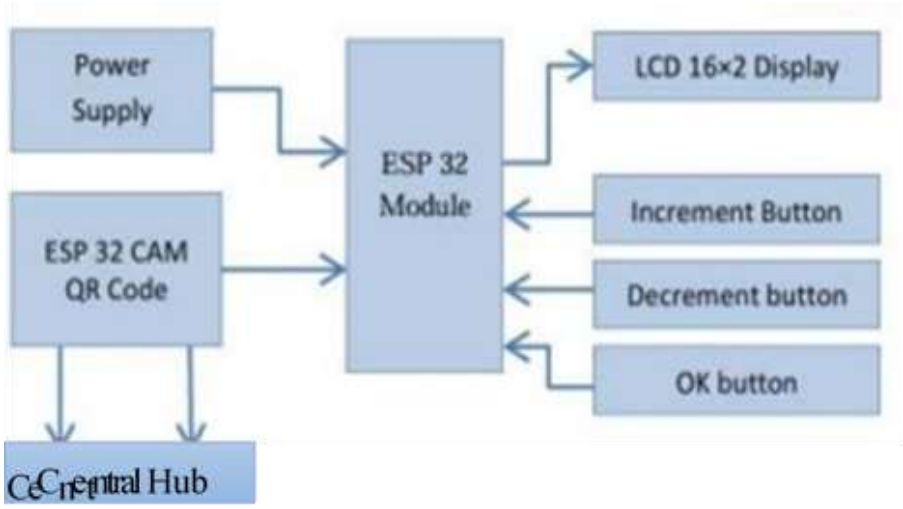

Fig. 1. Block diagram of smart trolley

This system uses the barcode of every product to do billing using a barcode reader. To simplify this process, some organizations have developed smart cart systems with RFID readers that can scan products and generate a bill automatically, and with a touchscreen display that allows customers to browse and search for products and make payments using mobile wallets. However, these existing smart cart systems have some limitations, such as the inability to suggest alternative products or make recommendations based on customer purchase history. Also, it cannot track the location of products within the store, which can make it difficult for customers to find specific items. Therefore, there is a need for further improvements to enhance the shopping experience with smart cart systems

Various researchers have explored the use of technology to improve the shopping experience. One of the most promising solutions is the Smart Cart system. This research study discusses the development of a Smart Cart system that utilizes various technologies such as OCR, voice assistance, and quick billing to improve the shopping experience for users, especially those with disabilities. The study addresses the limitations of traditional shopping methods and proposes additional features that could be added to the Smart Cart system to make it more efficient and user-friendly.

II. LITERATURE REVIEW

Customers using the Smart Trolley can scan and pay for their things with the help of RFID. Carrying out experiments in a real shop helps checkout be quicker, reduces mistakes and makes customers joyful. Since it breaks down each transaction, plays melodies, offers instant payment and is simple, the machine helps a lot. It becomes clear after reading literature that automation is necessary as people spend a lot of time building up lines. In the future, AI could provide customers with tailor-made services, secure their information from risks online and be available on multiple e-commerce websites. Additionally, this system can be changed and used in various shops. COVID has proven that remote work is advantageous, so people's feelings are generally favourable. Smart Trolley is beneficial for automated stores by making shopping simpler, more intelligent and safer.[1] In this project, you'll see a smart shopping cart created for persons with disabilities. An Arduino board, ultrasonic sensors and Pixy camera are used to steer it so as not to crash into anything. The simple and low-cost system tries to offer users greater flexibility when shopping.[2] Smart Shopping Cart was introduced to ensure that checkout is quick for customers and browsing products is a breeze. RFID and barcode scanning, along with a touchscreen and automatic checkout, means customers spend less time with staff, the company can see what products are in stock at all times and it's more secure.[3]

Approach involving technology based on IOT in the retail industry trolleys have been introduced to reduce the time people spend lining up for the bill. An RFID the reader handles the role of logging prices in the admin site. The process of billing takes place inside the trolley. People are able to pay. Online or by using the RFID counter at the cashier. in the car that we used. Having intelligent carts and automatic shelves Effectiveness of products can be increased by identifying them

properly the demand from the market [4]. The smart shopping cart is made for visually impaired people can be designed based on a certain study and used on the field every shopping mall. It has the ability to assess the things the user enters. You can use the internet to discover the availability and receive information from the company information on how to reach the place. There is a button on the app for requesting any necessary staff Help if there is a need.[5]

An autonomous shopping cart is presented in this research that tracks the shopper, scans goods using RFID and calculates the price directly in the database. To create the system, only Raspberry Pi, a camera and motors were required. As a result, the product helped save on work and time during checkout and performed well in a mall experiment.[6]Radio-frequency identification (RFID), images from cameras and electronic weight sensors are all part of an intelligent shopping cart that lets people shop without waiting, organizes a store's inventories and meets customers' needs, but there are some problems with its initial expense and the technological aspect.[7]With all the equipment on the Arduino Nano, RFID, LCD and Wi

Fi, checking prices, maintaining goods and making bills for buyers becomes simple. They provide better customer experience, reduce time spent waiting in lines at tills and require fewer employees to work at malls. Since cash registers are easy to use, affordable and adaptable, they are common in today's shops.[8] Because of the RFID and microcontrollers, you can quickly complete your checkout with your bill. The use of LCDs, central billing and QR codes results in improved client care, low chances of fraud and an uncomplicated daily flow at the store.[9]

RFID, NFC and a PIC microcontroller are used in this IoT smart shopping cart to automate the billing process, lessen waiting lines and help customers. It shows real-time updates for products, wireless data can be sent to your mobile phone and you can deter theft with the app. Smart retail stores will become even smarter if they use AI, GPS and GSM.[10] Barcode scanning, Raspberry Pi and wireless modules are used in this cart to automatically handle billing and minimize the wait for customers at checkout. Supermarket staff can monitor products in real time, improve the way services are provided and use a system that helps them work more efficiently.[11] The purpose of this project is to design an RFID smart shopping cart that automatically bills, finishes fast and constantly shows the total amount spent on an LCD. An item's data is sent wirelessly to a central point, making shopping easier for customers. Use of the system requires fewer staff members, helps improve customers' experiences and could involve integration with mobile in the future

III. PROPOSED MODEL

According to the model, enhancing the shopping experience is achieved by including new features in the shopping cart and making it convenient and satisfying for all users. A number of IoT and AI modules are included in the smart cart to handle various functions. Using Natural Language Processing, a grocery list handwritten on paper is turned into digital words that appears on the screen. The system leads the user to the products as fast as possible and displays whether they are present in the store.

Should the user add something not on the list, the system will show it with a highlight or issue a beep. Voice assistance helps people who cannot see the products by giving details such as the location and price of each item. Clients are given a POS machine attached to their cart and their receipt goes directly via email after they pay. It makes use of both IoT and AI to accomplish these goals.

The smart cart architecture is implemented by integrating various modules of IoT and AI to fulfil different requirements. The handwritten list of groceries is inserted into the scanner, which converts it into text data using Natural Language Processing, and displays it on the screen. The display then navigates the user to all the item locations via the shortest possible path and suggests whether a product is available in the shop or not. If an unwanted item that is not on the list is in the cart or falls into it by mistake, an alert is given to the user with a short beep sound or by highlighting the item on the screen. Voice assistance is also incorporated in the cart for visually impaired people, which directs the user to the specific path to reach the item's spot and provides information about the product, such as its name and price. Table I provides a comprehensive comparison of the features between existing and proposed models.

TABLE I

COMPARISON OF PROPOSED SYSTEM WITH TRADITIONAL SYSTEM

Feature/ Functionality	Proposed IoT-Based Smart Cart System	Traditional Shopping Cart Systems	Remarks
Item Identification	Uses RFID technology for instant product scanning and identification.	Relies on manual barcode scanning at checkout points.	The RFID system allows for faster and more efficient item identification, reducing checkout times.
Product Verification	Integrates image processing cameras to cross-verify product identity.	Lacks automatic verification; prone to human error in manual scanning.	Enhanced accuracy in product identification and billing.
Weight Verification	Weight sensors ensure the physical weight matches the expected weight of products.	No weight verification leading to potential inaccuracies.	Adds an extra layer of security against theft and billing errors.
Customer Interaction	Interactive display provides real-time information on products, prices, and offers.	Limited interaction, with information available only at checkout.	Improves customer experience by offering transparency and engagement.
Checkout Process	Enables instant checkout without queues, directly from the cart.	Requires customers to queue at checkout counters.	Significantly reduces customer waiting time, enhancing satisfaction.
Inventory Management	Real-time inventory updates through RFID tags and central system integration.	Manual inventory checks or delayed updates due to barcode scanning.	Provides accurate and real-time inventory tracking, reducing stock discrepancies.
Data Collection and Analytics	Collects valuable consumer behavior data for analysis.	Limited data collection, mostly at the point of sale.	Offers insights into shopping patterns, aiding in strategic decision-making.
Cost and Maintenance	Higher initial investment but reduced operational costs over time.	Lower initial cost but higher long-term operational expenses.	Although the initial setup cost is higher, the ROI is greater due to operational efficiencies.
Security and Privacy	Incorporates advanced security features for data protection.	Basic security features, primarily at the payment stage.	Ensures higher levels of customer data security and trust.

IV. METHODOLOGY

A. Designs

1) Flow Chart:

The flow chart, in Fig. 1, shows the step-by-step activities performed by the user while shopping. The trolley with smart features is more efficient than a normal trolley because it benefits from the latest technology.

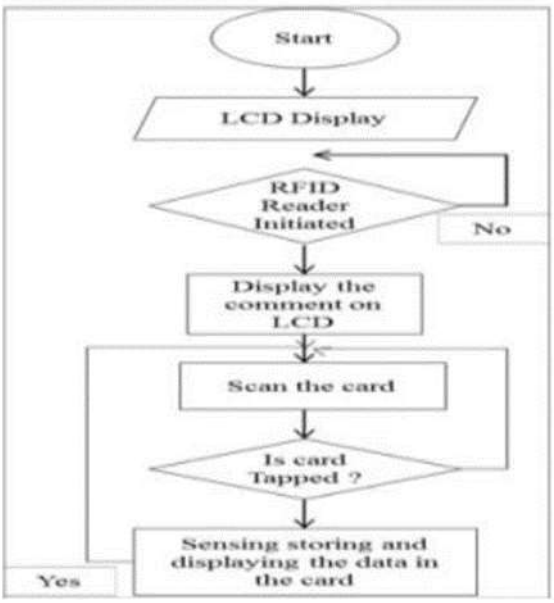

Fig. 2. Process Flow Diagram for Smart Cart System

Once a code is scanned by the QR scanner attached to the NodeMCU ESP32 device, the name and price will appear on the LCD monitor. Press the buttons on the console to alter

the items, because the system will then recalculate your costs. The upload key allows you to transfer the recent data to the billing office. You won't need to stand in long queues at the store if you use this system.

As well as generating live bills, the smart cart is also accessible through a web server so details about each product and its price can be reviewed using any computer or phone. As the method is easy to use, people do not need to learn anything extra. Due to all item info being on the LCD, customers can feel sure the display is valid. Today, shops are choosing these carts as automation currently Favors them because they move quicker and are not as cumbersome to operate. Stores are being transformed, as smart carts manage to do shopping choices and immediate billing.

2) Component Diagram:

On the diagram, you can see four elements all cooperating to deliver an effortless shopping process. The Shopping Mart section makes sure all operations are carried out smoothly. In the Shopping Cart component, customers have the option to put items in their cart or remove them. Keeping track of products, checking prices and stock is the work of the Product component. Moreover, the Database has all important information such as client records, descriptions of products and a record of transactions. All of these features make it a helpful, easy and simple method for shopping.

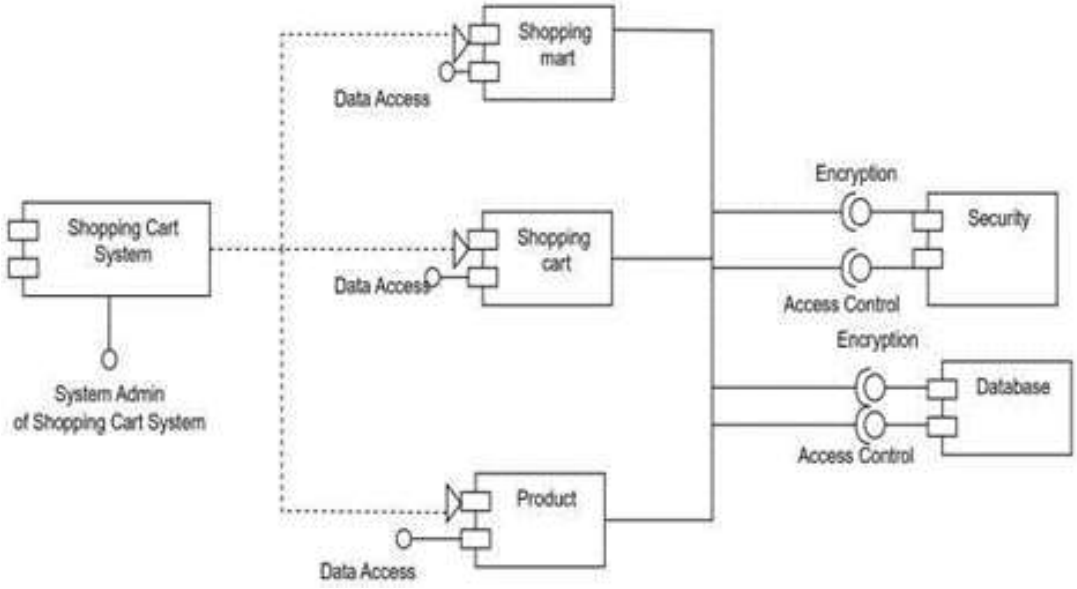

Fig. 3. Component Diagram for Smart Cart System

B. Modules

1) Unwanted and Redundant Items:

If an item is by accident put into the shopping cart. If an item is repeated on the list, the system will point it out. Display the screen and give a short sound alerts to the user. This feature makes sure the user can only acquire the things they help to identify and prevent errors in billing.

Technologies Required:

- Approaches like object detection are part of computer vision and recognition.
- Models for machine learning and image segmentation
- Using rules to control which messages to receive. Redundant items

computers etc. The details that have been or heads unless they are unavoidable displayed on the LCD such as name, price, and total amount and removed items will be displayed on the webpage in the form of bill. The general information of all the products can be clearly viewed on the created webpage.

- Switches: This system has two kinds of switches such as total switch which will help to display the total amount of the products and if the customer wishes to remove any item from the cart, the remove switch is used for removing the items from the LCD and also from the ESP8266 Wi-Fi module.

B. Software Details

- Embedded C: The programming part of the embedded system can be done by using the embedded

C. In order to interact with the hardware components, the language known as embedded C is used. The Arduino IDE software is used for coding the Arduino with the help of the Embedded C.

V. CONCLUSION

The AI-Enhanced Smart Shopping Cart integrates IoT, AI, and RFID to modernize traditional shopping.It automates billing and provides real-time product tracking, reducing long queues and checkout delays.Offers personalized recommendations and navigation assistance, enhancing the overall shopping experience.Supports mobile app integration for seamless updates, payment, and purchase tracking.Improves accessibility, especially for visually impaired users, with features like voice guidance.Enhances store efficiency through better inventory management and reduced manpower at billing counters.Despite high initial costs and technical challenges, the system promises long-term benefits for both customers and retailers.Overall, it contributes to a faster, smarter, and more customer-centric retail environment

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