

Smart Shopping Trolleys and Their Role in Streamlining Checkout Processes

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Abstract

Nowadays, shopping and browsing in large shopping centers has become a common occurrence in urban areas. Particularly on holidays and weekends, there is a significant crowd at malls. The crowd increases even more when there are special promotions and discounts. Customers buy various items and place them in their shopping carts. Once they have completed their shopping, they proceed to the cashier for payment. The cashier then generates the bill using a barcode reader, which can be a time-consuming process and results in long lines at the checkout counters. This study aims to reduce the queues at the billing counters in shopping complexes. The smart trolley achieves this by displaying the total price of the items in the cart. This allows customers to make direct payments at the billing counter and leave with their purchased items. The hardware components include Arduino Uno, and radio-frequency identification (RFID) Reader Module, an RFID card, and a buzzer. This system eliminates the traditional scanning of products at the checkout counter, thereby streamlining the shopping process. With this system, customers are informed of the total amount to be paid, enabling them to plan their purchases accordingly and focus on buying essential items, leading to increased savings. Since the billing process is automated, the likelihood of human error is significantly reduced. Additionally, the system allows customers to delete scanned products to further enhance their shopping experience. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs a light on a sensor, a finger on a button, or a Twitter message, and turn them into an output-activating motor, turning on an LED, publishing something online.

Keywords: Arduino, trolley, RFID cards, buzzer, Arduino UNO

INTRODUCTION

Shopping centers play a crucial role in providing a wide array of daily necessities to individuals from different backgrounds, including food products, clothing, toiletries, gardening tools, and electrical appliances. The global increase in demand has led to the growth of both small and large shopping malls, resulting in varying levels of development in shopping center systems and infrastructure. An Internet of Things (IoT) system is a network of networked devices that each have a unique identity attached to it so that data can be transferred over the network without the need for human involvement or human-computer communication.

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An Arduino Nano, weight sensor, Raspberry Pi, radio-frequency identification (RFID) reader, and LCD are required for a smart shopping cart. The RFID reader reads the product information when the

customer places the items in the smart cart and is then sent to the Raspberry Pi via the Arduino Nano. The Raspberry Pi then verifies the tag information with a database that is already stored in the Storage Devices (SD) card to show the product information on the LCD.

This process is repeated until the client's shopping is concluded. Two buttons are given on the trolley, which helps to add or remove the products from the trolley, and each product is added to the trolley and then moves for further shopping. The entire system is based on user preferences. After shopping, customers can pay right away and leave the mall.

While some foreign countries have more advanced shopping mall systems, there is still room for improvement in delivering a high-quality shopping experience for consumers. Issues such as financial constraints, a lack of product information, and long checkout times are common challenges faced by customers. Solutions such as barcode scanning technology and customer-friendly checkout processes have been suggested to enhance the overall shopping experience. The Arduino has two common functions, `setup()` and `loop()`, which are automatically called in the background. The code to be executed is written in curly braces within these functions. `void setup()`. This includes the initial part of the code, which is executed only once. This is called the preparation block. RFID cards are used for applications where tracking or identifying personnel is important or where access control is required. Various RFID frequency bands are utilized in cards today, including a 125 kHz low-frequency proximity, 13.56 MHz high-frequency smart card, and 860–960 MHz ultra-high frequency (UHF). RFID technology is used extensively for asset tracking, allowing businesses to monitor and manage valuable assets efficiently. RFID tags attached to assets such as equipment, vehicles, or tools enable real-time identification and location tracking [1, 2].

LITERATURE REVIEW

The research paper titled “Smart Shopping Cart with Automated Billing System Utilizing RFID and ZigBee Technology” [3], authored by P. Chandrasekar and T. Sangeetha, was presented at the International Conference on Information Communication and Embedded Systems (ICICES2014). This study introduced a novel approach that employs RFID and ZigBee technologies to establish an automated central billing system for shopping malls. The system was designed to eliminate waiting for lines and provide real-time pricing information for items within the cart, thereby improving the overall shopping experience. Another relevant study, “RFID-Enabled Smart Shopping Cart for Automatic Billing,” [4] authored by Zeeshan Ali and Prof. Reena Sonkusare, was published at the IEEE Conference in 2013. This study emphasizes the incorporation of LCD screens that facilitate item removal via a cancel button. This underscores the significance of having access to real-time data regarding various products contained within the shopping cart.

This review provides insights into the different implementations of smart shopping trolley systems, shedding light on their functionalities and benefits in retail environments [5].

Advancements and challenges in smart shopping systems: Author: Mamta Published in 2022 This article discusses the latest trends in smart shopping trolley technology, such as IoT integration, real-time data analytics, and personalized customer interactions [6]. It also addresses challenges such as implementation costs and data security concerns and proposes solutions such as encryption methods and user anonymity for mitigation. A buzzer is an electronic component that generates sound through the transmission of electrical signals [7]. Its primary function is to provide an audible alert or notification, and it typically operates within a voltage range of 5 V to 12 V. The buzzer symbol had a semicircular shape. To add a motor to the circuit, draw a circle with the letter M in the middle [8]. A component called a resistor controls the flow of electricity through a circuit.

METHODOLOGY

The first step involves conducting a comprehensive needs assessment to comprehend the specific requirements of both customers and the store [9]. This includes collecting data on shopping behaviors,

peak shopping times, inventory challenges, and customer input. The goal is to pinpoint the key areas in which a smart trolley system can improve operational efficiency and customer satisfaction. Following the needs assessment, an elaborate system design was formulated. This design encompasses hardware elements (such as scanners) and software solutions (including inventory management integration, payment systems, and user interfaces). The design phase also ensures compatibility with existing store systems such as point-of-sale (POS) systems and Wi-Fi infrastructure. Prior to the full-scale implementation, a prototype of the smart trolley was developed. This prototype was tested in controlled environments to assess its functionality and user-friendliness [10]. Adjustments and optimizations are implemented based on the test results to enhance both the hardware and software components. A flowchart is shown in Figure 1. A pilot test was conducted in specific sections of the Big Bazaar stores. This small-scale deployment aids in understanding how smart trolleys perform in a real-world environment and enables the collection of data on user interactions, system stability, and the overall impact on shopping efficiency and experience. Simultaneously with pilot testing, the store staff receives training on how to operate and manage the smart trolley system [11]. This training covers resolving common issues, assisting customers in using the trolleys, and managing the integration with the store's inventory and checkout systems. Trolley, as illustrated in Figure 2. User Feedback and System Adjustment: Feedback from the users and store staff during the pilot phase is essential. This feedback was analyzed to pinpoint any issues or potential enhancements. Adjustments were made to the system based on this feedback to improve its performance. Figure 1 is a block diagram showing the information flow.

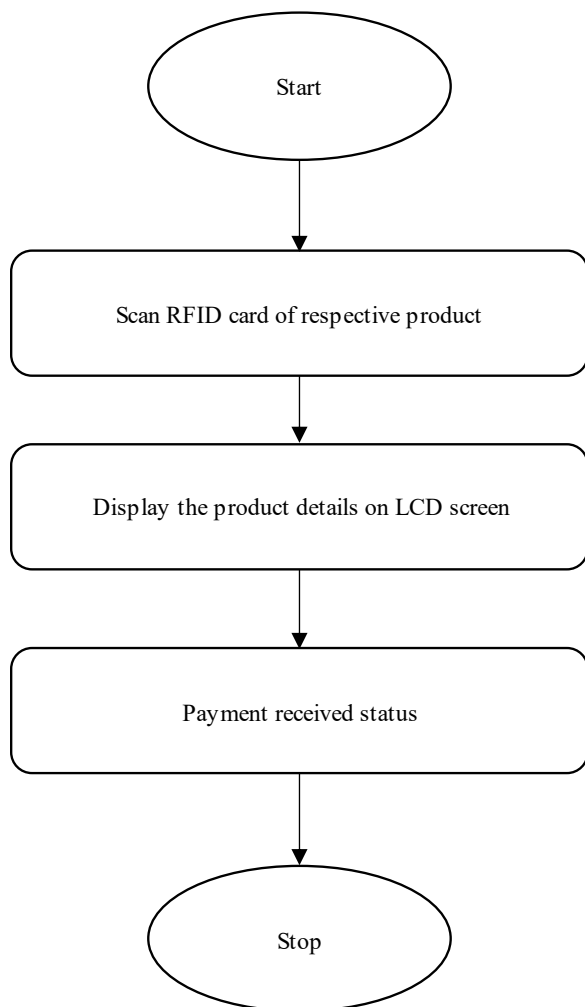


Figure 1. Flow chart of the smart shopping cart system.



Figure 2. Trolley.

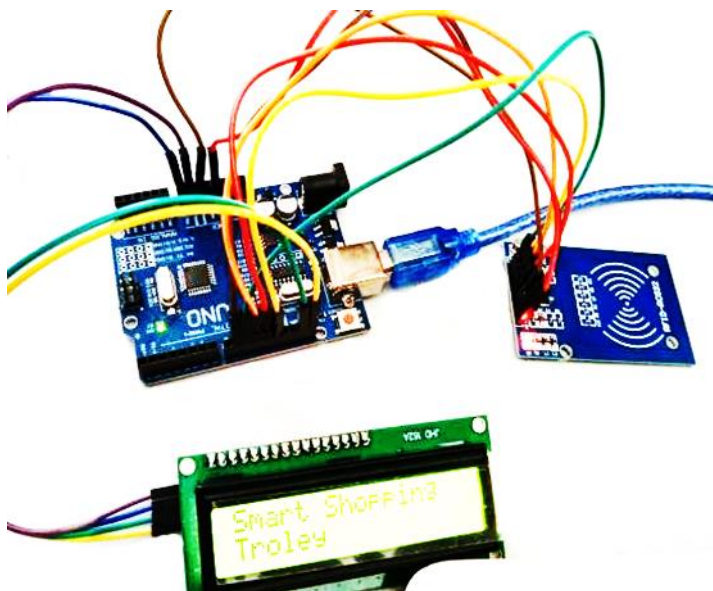


Figure 3. Working circuit.

We plan to employ passive RFID tags that operate at a frequency of 125 kHz [12]. The transponder was attached to the object and consisted of a small microchip and an antenna. RFID tags are available in various sizes, shapes, and forms. Wireless communication between the RFID Reader and tags was established without the need for a direct line-of-sight [13]. An RFID reader can penetrate most materials and emit a low-power radio-frequency field to power up the tag and transmit stored data. An LCD connected to an Arduino Uno is used to display customer actions such as inserting or removing items, the value of items, and the total requested value of items in the cart. The working Circuit is illustrated in Figure 3. At the checkout counter, the cashier calculates the total number of items, collects payments, and provides the customer with the total bill [14].



Figure 4. Message display.



Figure 5. Product scanned.



Figure 6. Price display.

RESULTS AND DISCUSSION

To initialize a smart shopping trolley, you will need to incorporate various technologies like RFID, sensors, and a display screen. The message display is illustrated in Figure 4. These components would enable features such as automatic item scanning, tracking of items placed in the trolley, and even integration with a mobile app for payment and personalized shopping suggestions. The Scanned products are shown in Figure 5. It is a blend of hardware and software aimed at enhancing the shopping experience [15].

Your wheat card has been scanned, and now you can start using a smart shopping trolley. You will have access to features, such as automatic item scanning, personal recommendations, and seamless payment options. The price display is shown in Figure 6. Enjoying a shopping experience. You can continue browsing and adding more items, and the system will keep track of everything. If you need any assistance or want to check it out, let me know. The display screen of the smart shopping trolley shows the total number of items added and the corresponding total cost. This real-time display keeps you informed about your purchases at your shop.

CONCLUSION

The growth of science and technology has been a gradual and consistent process. Currently, cutting-edge devices and technologies are being developed. This application is utilized in shopping centers to assist users in saving time during their purchases. RFID was employed as a security access method for the items in this project to enhance surveillance capabilities. Implementation of this technology in shopping malls and supermarkets will initiate an automated central billing system. As a result, shoppers no longer need to wait in line at counters for payment, as their purchase information is transmitted to the central billing unit. This significantly streamlined and simplified the billing process. In addition, this method ensures that instances of theft by dishonest consumers are identified, making the system more reliable and attractive to both buyers and sellers. This elevates the shopping experience to a new level. The LCD screen mounted on the cart displays various details such as item cost and name. Therefore, it is anticipated that automatic product billing using RFID technology will become a more feasible option in the near future, making operations more efficient and systematic. The prototype model successfully achieved its objective. The product design is cost-effective, user-friendly, and requires no

special training. Decision-making can be performed directly in the cart, providing a convenient and innovative way for customers to shop in malls, saving their energy, time, and money. The project was evaluated through various trial scenarios, with different items tested for each trial. The cart was only capable of transporting water-sensitive products because of the water-sensitive tags used in this project. Furthermore, the circular placement of tags on products is due to their single-sided detection capability.

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