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An Automated Billing System for Smart Shopping Using Internet of Things

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Abstract
Shopping malls can be crowded, making long checkout lines frustrating. This proposal outlines a "smart cart" system to streamline the billing process. The trolley has a RFID reader and camera to read the tags and capture images respectively. This trolley has two more cameras at two sides of the trolley to capture the images of the objects in the rack. This can accurately detect the objects and later the product has entered into the cart. The main objective of this project is to reduce the time required for this Accounting system at bill counters. If you want to remove a product you added, you will need to rescan the product. In case the object is not detected by the barcode then the camera attached to the RFID reader captures the images of the product and stores to cart using the Database. This is done using a smart shopping system based on RFID. Items that are put in a smart shopping cart are read one by one and the bill is generated and displayed. After completion of shopping, customers can exit the shop with their bills deducted automatically from their e-Wallet.
Keywords: *Arduino; Automated Billing System; RFID; Sensors; Trolley.*

1. Introduction
In modern days, people are getting too busy with their work but still they need to spend time in shopping malls. In Shopping malls, customers face a difficulty to follow a queue for the process of billing, which takes a long time under huge crowds. This paper proposes an innovative solution: a “smart cart" system. This system utilizes a combination of RFID readers, cameras, RFID tags, and weight sensors to automate the billing process, significantly reducing checkout times and improving the overall shopping experience. This paper builds upon existing research in smart shopping technologies by offering a more comprehensive approach. We discuss the limitations of traditional barcode-based systems and highlight the advantages of integrating RFID technology, infrared sensors, and weight verification. The increasing popularity of online shopping, which offers a frictionless checkout experience, further highlights the need for innovative solutions to bridge the gap in physical retail. Traditional barcode-based checkout systems, while prevalent, have inherent limitations. Additionally, manual scanning by cashiers introduces the possibility of human error. While some stores have implemented Self-checkout kiosks, these can be cumbersome and require customers to bag their own groceries, adding another layer of inconvenience. Recent advancements in artificial intelligence, sensor technology, and the Internet of Things (IoT) have paved the way for the development of smart shopping solutions. Existing implementations often utilize RFID tags for automatic product identification, offering some level of convenience. However, these systems may lack the sophistication to handle a variety of product types or address potential inventory management challenges. Our proposed smart cart system addresses the limitations of existing solutions by offering a more comprehensive and user-friendly approach. The integration of barcode readers, cameras, RFID tags, weight sensors, and AI algorithms creates a robust system capable of accurately identifying and billing for a wide range of items. This not only streamlines the checkout process but also provides valuable data for

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inventory management and targeted marketing strategies. By addressing these critical aspects of the shopping experience, our system has the potential to revolutionize the retail landscape for both customers and retailers. [6-9]

1.1. Related Prior Works

[1] System, Method and Design of Automatic Billing System Abstract: In this paper, the patent disclosure covers System, Method and Design of Automatic Billing System. Hence this project aims to reduce the average time spent by the customer at the shopping mall by implementing an automatic billing system using RFID technology. The main aim of the patent disclosure is to satisfy the customer and to reduce the time spent on the billing process which is to complete the billing process in the trolley rather than waiting in a queue even for one or two products. The customers must add the products after a short scan in the trolley and when the shopping is done the finalized amount will be displayed in the LCD display.

[2] RFID Tag Technology for Automatic Payment Shopping Applications: In this study, their product will overcome the problem of standing in a queue and wasting time. Our product smart trolley billing system will audit the purchased products and the payment is made online automatically using the RFID tag. It will automatically identify and scan the product, and the final billing is made from the cart itself. It also provides a centralized and automated billing system using RFID. In this system, every product in the mart will have a RFID tag, and every cart will have a RFID Reader attached to it. These features will save time and make shopping easier.

[3] RFID Scanner and Provisional Billing at the Exit: In this paper, every product in the retail marts is attached with RFID labels consisting of the exact details of the nature of the product and lot batch. During the billing of these items it may happen that some products may not have been billed due to some reasons and still those items get their way into your shopping bags. A provisional billing screen will be placed wherein the customer can see which product/s are yet to be billed, allowing them to make a transaction if they choose to discard the product.

[4] RFID Based Automatic Shopping Cart: In this paper, the model keeps an account and uses of the existing developments and various types of radio frequency identification and detection technologies which are used for its recognition, billing and inventory update. As the whole system is becoming smart, the requirement of manpower will decrease, thus benefiting the retailers. The time efficiency will increase phenomenally since this system will eliminate the waiting queues. More customers can be served at the same time thus benefiting the retailers and customers as well.

[5] RFID Based Intelligent Smart-Cart System for Automatic billing: In this study, the method barcode labels will be given for each product that can be read by a specially designed barcode reader. During the season of huge sales, this condition would probably get worse, or if the shopping center still uses the traditional way to hand-key the price of each item to the checkout counter. There will also be a centralized database that will automatically update stock and order after the goods are paid for. The LCD screen on the shopping cart assists the consumer in purchasing items.

2. Method

In this paper, we attach an RFID tag to each item in the shopping center and a reader to the shopping cart. After purchase, the reader scans the product. Each tag has a unique EPC. Figure 1 shows Architecture of Automated Billing System. Based on the EPC received by the Arduino, product information is displayed on the LCD along with the updated cost. This information is also transmitted to a central PC using the cart's transmitter and the PC's receiver. To remove a product you added, rescan it. [10-14]

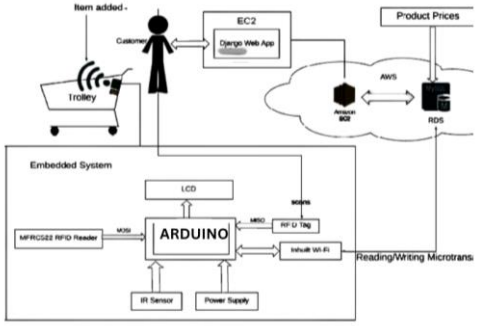

Figure 1 Architecture of Automated Billing System

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If the RFID isn't detected, the camera attached to the RFID reader captures images and stores them in the cart's database. The cost of the corresponding product is deducted from the invoice. A push button on the cart indicates the end of shopping. After pushing it, the final bill displays on the LCD. Unique RFID tags provided to each customer, contain information like customer identification numbers and card balances. Scanning a prepaid card initiates payment on the trolley itself, and the LCD shows the remaining credit. All this information is available on the central PC's serial monitor. Additional cameras at both corners of the trolley detect objects on the rack, helping the shopkeeper manage inventory. [15-18]

2.1. Proposed System

The proposed system has a number of advantages, including the significant reduction in checkout lines. Automatic item identification eliminates the need for manual scanning, leading to a faster and more efficient shopping experience. Figure 2 shows Flowchart for RFID Reader Module. RFID technology eliminates human error associated with traditional barcode scanning. This translates to fewer billing mistakes and ensures customers are charged correctly. [19-22]

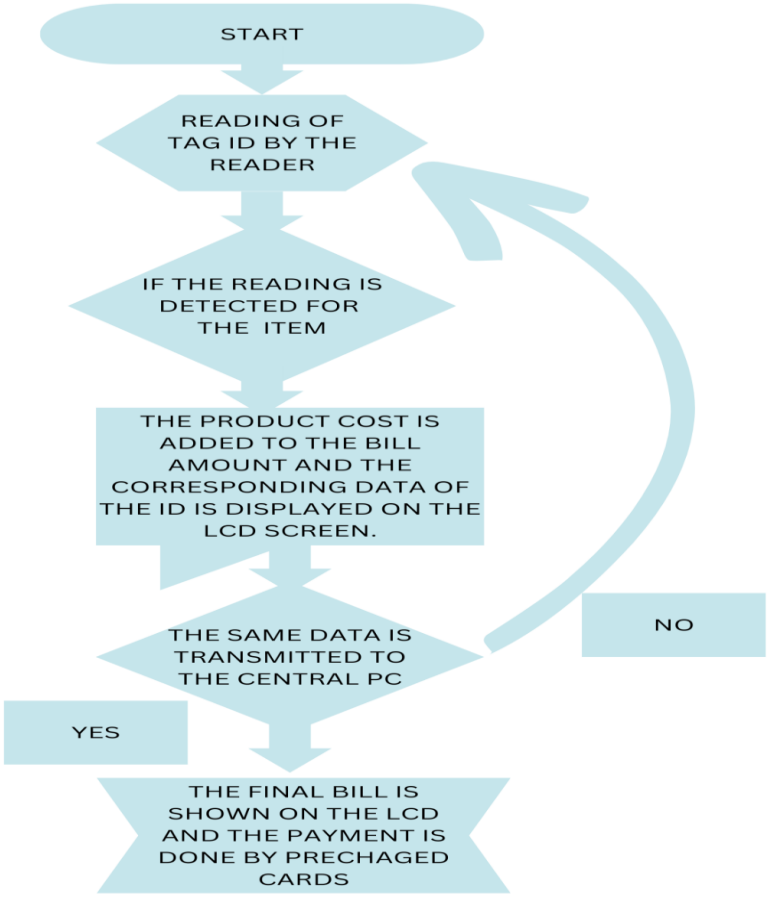

Figure 2 Flowchart for RFID Reader Module

The automated billing system using RFID comprises a layered architecture that seamlessly integrates RFID hardware with billing system software to automate the billing process, enhance customer experience, and improve overall operational efficiency. RFID tags attached to products provide unique identifiers and product information, while RFID readers capture this data and transmit it to the RFID middleware. The middleware processes the raw RFID data into meaningful product information and integrates it with customer data from the billing system software. Based on this integrated data, the billing

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system software generates accurate invoices and facilitates secure payment processing. A robust network infrastructure connects the RFID readers, middleware, and billing system software, enabling real-time data exchange and system communication. Data encryption and access control mechanisms safeguard sensitive customer and financial information, ensuring the system's integrity and confidentiality. [23]

2.2. Experiment Procedure

The following procedures were followed in Gathering the necessary components first, such as an Arduino UNO or NANO, an RFID reader, and a camera module. Using resistors, connect the components through the breadboard. Connect the LCD screen so that the newly added item to the cart can be seen. After which the item is automatically added to the database by connecting the Arduino to it. The database includes all of the details regarding the prior buying and provides some recommendations as well. The camera sensors that are affixed to the trolley and are utilized to offer recommendations on LCD displays. [24]

2.3. Hardware Description

Arduino

The Arduino Uno (Figure 3) is a microcontroller board that is open-source and is based on the Microchip ATmega328P microcontroller. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. The hardware is a physical circuit board, and the software is used to write code for the board. Arduino boards are popular for beginners in electronics because they are relatively inexpensive and easy to learn. They can be used to control lights, motors, and other devices. This board is used here to attach sensors such as ADXL335 accelerometer sensor, Pulse heart-rate sensor and MAX30205 temperature sensor in the board and the data is collected over a particular period of time.

Figure 3 Arduino

RFID Reader

Figure 4 Radio Frequency Identification (RFID) refers to a wireless system comprising two components: tags and readers. The reader is a device that has one or more antennas that emit radio waves and receive signals back from the RFID tag. The reader emits a signal that activates the tag, causing it to transmit its data. RFID readers come in various shapes and sizes, from handheld scanners to doorway portals. There is a device that reads information contained in a wireless device or “tag” from a distance without making any physical contact or requiring a line of sight. [25]

Figure 4 RFID Reader

Wi-Fi Module

Figure 5 The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. It allows the device to connect to the internet wirelessly. This tiny circuit board typically includes an antenna for sending and receiving Wi-Fi signals. The module translates data between the device and the network, enabling communication. [26]

Figure 5 Wi-Fi Module

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Camera Sensor

Key to this is the image sensor at the heart of every digital camera it was shown in Figure 6. Just as the retina in the human eye captures light and translates it into nerve impulses that the brain can interpret, the sensor captures light and converts it into an electrical signal that is then processed to form a digital image. These tiny light-sensitive chips consist of millions of pixels, each recording a specific color value. The arrangement of these pixels determines the sensor's resolution, impacting image detail.

Figure 6 Camera Sensor

3. Results and Discussion

The automated billing system using RFID aims to streamline the billing process, enhance customer experience, and improve overall operational efficiency. The system will utilize RFID technology to automatically identify and track products, eliminating the need for manual scanning and data entry. This real-time data will be integrated with the billing system software to generate accurate invoices and facilitate seamless payment processing. Additionally, RFID technology can reduce cashier workload and checkout lines, leading to faster transaction times and increased customer satisfaction. Furthermore, the system can provide valuable inventory data, allowing for better stock management and reduced instances of out-of-stock products. Incorporating RFID technology can also potentially reduce shrink (inventory loss), further improving a business's bottom line. Figure 7 shows Output of the hardware.

Figure 7 Output

Conclusion

The implementation of an automated billing system using RFID can significantly enhance operational efficiency, improve customer experience, and reduce costs. By streamlining the billing process, automating product identification, and integrating real-time data, businesses can achieve a competitive edge and optimize their operations. Additionally, RFID billing systems can deter shoplifting through automatic product tracking, minimizing inventory loss and improving security. Furthermore, the collected data can provide valuable insights into customer buying habits, allowing businesses to personalize product offerings and promotions, ultimately increasing customer satisfaction and loyalty.

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research community for their ongoing exploration of innovative technologies that have the potential to revolutionize the shopping experience.

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