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A Survey on RFID Based Smart Shopping System and Automated Billing

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Abstract - *In traditional malls, during checkout each item is scanned individually, this increases the time for billing. In recent years the concept of convenience store has undergone a phase of evolution due to the vital changes in the consumer's lifestyle. Studies show that on an average, 5-10 minutes is the maximum tolerable amount of time customers are willing to wait in line. Customers feel that unoccupied time feels longer than occupied time. The existing checkout systems use Bar-codes. Replacing Bar-codes with RFID tags, multiple items can be scanned thereby saving time. Radio Frequency Identification System (RFID) concept uses communicating with the RFID tag at different frequencies. RFID readers communicate with RFID tags using radio waves. Therefore, it is not necessary that the tag is in the reader's field of view to be scanned. The aim of this survey is to create a design for a smart shopping cart based on RFID technology.*

Key Words: Radio Frequency Identification (RFID) reader, RFID tags, Barcodes, flutter application.

1.INTRODUCTION

The advancement in technology makes use of the concept of sensors. This is the underlying notion in IoT in which the data can be sent from one place to another in no time with the help of Internet. Earlier, RFIDs were used in warehouse management. RFID has led to a refinement in information technology that has profoundly altered people's lives. RFIDs have a much more complex mechanism than barcodes which provide more security. RFIDs possess the advantage of reusing it thereby saving money. So, tagging each item with an RFID and scanning it while shopping, speeds up the entire process and therefore eradicating queues.

RFID has an edge over standard barcodes. This is owing to a severe drawback of line-of-sight technology as well as the short lifespan of these barcode tags. RFID tags, on the other hand, are resistant to tampering and can read and write encrypted data. These tags can store large amounts of data, such as product information like unique product identifier, product name, price, and expiry date.

RFID can locate and track tags affixed to things using electromagnetic waves. An RFID system can be identified in three parts: a transceiver, a scanning antenna, and a transponder. An RFID reader or interrogator is produced when the scanning antenna and transceiver are joined. The transponder is present on the body of the RFID tag. There are two distinct types of tags: Active and Passive.

An active RFID tag has its own power source, which is often a battery. Electromagnetic waves from the reading antenna generates a current in the passive RFID tag's antenna, energizing the tag.

Attempting to read many tags at once may result in signal collision and finally data loss. At an extra cost, anti-collision techniques can be employed to prevent this. These techniques, which seek to minimize overall read time while increasing the number of tags read concurrently, are still under development.

The overall problem of RFID collisions may be divided into two categories:

1. When a reader tries to interact with tags that are in another reader's seeing range, a reader collision occurs.

Signal interference occurs when the fields of two or more readers interact and overlap with each other. By setting each reader's reading schedule to occur at a little different time, this problem can be solved.

2. Multiple reads of the same tag occur when it is read by each overlapping reader more than once.

In a normal store, the products are placed in different shelves and racks. Keeping track of these in-memory would be a hectic task. By storing all this information in the database can decrease the work for the in-house associates. Taking a 2-Dimensional map of the entire store, the coordinates of the products can be marked by the respective aisle number and the rack number they are present in.

Due to numerous utilities, smartphones have become an indispensable part of our lives. Google's Flutter software development kit is a tool that helps in developing native cross-platform (Android and iOS) applications using one programming language and one code base.

2. OBJECTIVES OF THE SURVEY

1. Identify and describe the key technologies, components and architectures employed in RFID-based smart shopping and automated billing systems.

2. Review the advantages and shortcomings of RFID-based smart billing and shopping systems, considering how they impact consumer satisfaction, operational efficacy, and cost-effectiveness.

3. Analysis and contrast different strategies and solutions for RFID-based smart shopping and payment systems.

3. LITERATURE REVIEW

Martinusa et al. [1] discusses a system consisting of a smart shopping cart, a smartphone application, a cashier application, and a database, where people can scan the items themselves and the cashier performs the payment. Each item in the supermarket will have an RFID tag containing the item's identifier and price. The database includes all information about every smart cart as well as each transaction that the supermarket's system has triggered. Before proceeding to the cashier, the consumer inputs the One Time Password (OTP) into the web application to obtain the relevant transaction list and finish the checkout process. Some of the advantages are tracking the current location of the cart, self-scanning and simplifying things by a factor of 2. One of the limitations is in the flexibility of payment.

RFID technology is used in study [2] as proposed by Shaikh Farhan Shahnoor et al. to monitor purchased products for billing purposes. The checkout locations can confirm the customer's purchases. It uses an RFID Reader, a Wi-Fi module and an LCD Screen. The technology has an impact on crowd management, effectively automates billing and saves customers' time. It does not have a phone-based optional application which would further reduce the time escalate customer satisfaction.

The components employed in [3] Thashini Krishna et al. work is, an Arduino Mega, an RFID reader, an RFID tag and a Bluetooth module. It implements an autonomous cart that can move without being pushed using multiple ultrasonic sensors. The scanning is incorporated into the shopping cart itself, and the scanned items are sent via a Wi-Fi module to a computer installed in the supermarket. The significant benefit of using an automated cart is that customers can quickly navigate through the cash counter and check out themselves.

The Arduino, LCD Display, ZigBee, Wi-Fi Module, and RFID Reader are the devices utilized in study [4] proposed by Rahul Chauhan et al. It assists consumers in locating the top offers on well-liked goods. The rating of a product is given according to its popularity and preference. It lacks security safeguards such as verification or authentication that the shop and the client may both employ.

An RFID-based Smart Shopping Automation System (SSAS) with an automatic bill calculator is employed in article [5] by F. Piyush Raj Rouniyar et al. All the merchandise in the mall have RFID tags attached, and the exit gate is a location within the mall with a modern RFID reader, LCD displays, sensor equipment, a microcontroller, and a backend server connection for computations. It focuses on saving the customers time and money. It is more trustworthy since it solely focuses on the exit gate.

[6] By Miss. Shubhangi et al. uses RFID Reader, Transmitter and receiver, Power supply, and Arduino Nano. The recommended system helps in tracking detailed versions of product information and gives product suggestions based on the user's purchase history from a centralized system. Total bill details are transferred to the personal computer (PC) at the checkout counter, through wireless transmitter and receiver modules. This futuristic approach cultivated in this project is echo friendly as it eliminates usage of paper.

Ng Xin Jie et al. [7] describes the latest and sophisticated RFID technology in order to minimize the theft problem by making use of the tracking mechanisms. It uses RFID to track the relevant information and then transmit it to the host system. Moreover, it aids in the provision of a self-checkout system and provides a payment feature so that customers may pay conveniently. It has been advised that it can also be used in supermarket parking systems.

The product unique identifier produced by the RFID in [8] by the author, Sakorn Mekruksavanich et al. Server's database is compared to the product identifier that was generated. Furthermore, the promotional materials are a means of assisting customers in making an effective purchase. During the purchasing action, the billing information is updated, and the bill is simultaneously displayed. All the IoT components in the store may easily connect with one another using Zigbee. Also, it offers a comparison button to rate all comparable products on the store.

Introduction of a smart queue system defined by Naresh Babu Muppalaneni et al. [9] seeks to cut down waiting times. It also provides a useful means of having a flexible, minimal fuss and extreme framework for convenient means of purchasing support. It features an LCD display and an RFID reader to enhance the system's security measures. With information like time, date, and product characteristics, it stores the data in database in .csv (comma-separated values) format.

In [10] Shreya et al. describes shopping recommendations, product search, indoor navigation, and voice-based shopping assistants. Shopping recommendations are based on Apriori algorithm that recommends products to customers based on their valuable shopping history and current items in their shopping cart. Use Bluetooth Low Energy (BLE), Random Forest Regression, and RFID modules. Indoor navigation is supported by Wi-Fi and BLE networks, as traditional GPS (Global Positioning System) services are best suited for outdoor services.

The author Ruchi Gupte et al. of [11] explains how collaborative clustering can be used to enhance the shopping experience and satisfy client requests. The RFID reader and a Zigbee module used to upload user data are in the trolley. The customer must scan the item once again to remove it. It has been able to identify groups of related products and determine the connection between any two products by utilizing K-Means clustering.

The study [12] by Parameswaran Ramesh et al. discusses a smart trolley, which has an RFID reader, RFID tag, voice board, LCD display, QR online payment scanner, and childcare unit. The major objective of this work is to enhance the RFID-enabled payment process that is used on the trolley. It also concentrates on developing a model for automatic billing by including a childcare unit and QR scanner in the shopping cart.

Aarthi Rameshkumar et al. defines [13] that customers can add or remove items from their carts by using the membership card that has been allotted to them. Cards can be recharged and used for payment for successful and quicker transactions, reducing customer wait time at the billing counter. Using collision detection technology, the system can prevent labels from being recognized repeatedly. To ensure a successful and easy shopping experience, the scanned products and their prices are displayed.

The author [14] Manikandan T et al. describes how an RFID reader, operated by a micro-controller is installed in a shopping cart to scan each item that is loaded into it. A distinctive RFID customer card containing all necessary details about the consumer and the amount they have previously deposited will be given to each new customer. Customers must scan their smart card with the RFID reader included in the shopping cart to collect and assign shopping carts. After proper analysis, the customer will be prompted a password for authentication.

Ms. Rupali Sawant et al. [15] discusses an RFID-based smart shopping cart concept in the retail field. The proposed system would replace UPC codes with RFID tags that communicate with an infrared sensor that detect each item in a cart. This reader would be connected to a large network that would send product information to retailers and product manufacturers via a ZigBee module. When a customer enters the aisle with a shopping cart, the cart encounters the infrared receiver and the microcontroller looks for the aisle information code. The aisle information code is transmitted wirelessly from the cart to the server via ZigBee. The database is queried based on the aisle number received. The product can be placed in the cart and the RFID reader will read the tag.

S. Sai Ganesh et al. [16] described a customer picking up a shopping trolley. Each trolley consists of an RFID reader as well as a barcode reader. When a customer buys a product, they first scan the label with an RFID reader before adding it to their trolley. Price of the product is retrieved and stored in the system's memory when the customer scans the product label. The product name and price are displayed on the screen.

[17] By Ankush Yewatkar et al. suggests equipping each cart with an RFID reader and ZigBee Module. An online billing method is implemented. If a product is removed from the cart, it will be erased from the invoice. The RFID reader installed at the exit door adopts anti-theft mechanism. Offers/discounts are available based on customers` shopping habits.

Tejas Patil et al. [18] defines an intelligent shopping cart to display the total price of the products present in the shopping cart. This allows customers to pay the amount directly at the application or billing counter. The components used are an Arduino Uno, an RFID reader module, and a buzzer.

Amruta Pokale et al. designed a smart trolley that facilitates the customer's shopping experience [19]. With the help of the application, carts are assigned to customers. Product details such as the product name and price are displayed on the screen mounted on the trolley. Payment can be made using various payment options provided at checkout.

The system proposed [20] by Gogikar Bharath Kumar et al. contains Radio Frequency Identification (RFID) sensors, Arduino little regulator, a Bluetooth module, and a Mobile application. The data is shown in the mobile application when the user scans the product at the billing counter. This structure suggests replacing standard and monotonous systems with the use of emerging technologies such as IoT and Android.

4. CONCLUSION

RFID has a wide range of applications in retail that go beyond straightforward operational advantages to actively enhance the consumer experience. In its simplest form, it involves actions like boosting product availability and providing convenient services by allowing shop employees to spend more time serving consumers. A comprehensive and existent picture of everything makes it feasible to improve customer service and elevate sales. The smart navigation feature is one among the sophisticated features that could be enabled in the application.

Overall, the use of RFID speeds-up the billing process, thus enhancing customer shopping experience.

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