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Smart Shopping Cart System

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Abstract: *The billing system for shopping malls is usually time consuming. When there are a lot of items in the list, the time duration for billing is long as there is a queue for billing the items at the counter. This paper presents a model that reduces the time for billing using Radio-frequency identification (RFID). The smart shopping displays the bill and the customer can pay the bill online.*

Keywords: Smart Trolley, Smart Shopping, RFID, IoT (Internet of Things), Smart Cart

I. INTRODUCTION

According to the current scenario, shopping in malls has become a daily routine. Shopping involves visiting a store, examining the products and going through the billing section, waiting in long queues, scanning the products and finally paying the amount at the counter. However, sometimes people do not find it enjoying. Today's supermarket shopping is very labour-intensive. Anything that can be done to ease this burden would be convenient. The customers basically follow the same set of steps. Firstly, filling of the cart with items they wish to purchase, checkout that requires them to empty the cart and place them all on the conveyer belt. At this point, the cashier scans each item one-by one to display the cost of the goods for purchase. After this step, all the goods need to be bagged and then each bag needs to be reloaded back into the shopping cart for departure from the supermarket or mall [1, 2].

A significant amount of people are choosing online shopping which is comfortable over legacy schemes like window shopping. This has made people vigilant of the benefits that e-commerce holds over regular commerce. This generation, who has made online shopping as their default way of buying lifestyle commodities is yet to harness a similar way of shopping for day-to-day commodities [1, 2, 3].E-commerce companies like Amazon, Flipkart have paved a market of their own as they provide smallest of the house hold item to huge luxurious items at the fingertips of the customers. Varieties of Items are available online on these e-commerce sites. Therefore, in order to match up with online shopping, supermarket shopping can also be made online. The aim of the smart shopping cart is to reduce the shopping time. The customers themselves can make the billing, so it is easy for the customer to estimate the bill too. The shopping mall scan reduce the manpower at billing counters and space consumption [4,5]. These efforts and investment can be used to improve the quality and consumer experience. More number of products can be placed instead of billing counters to attract the customers. The main objective of this paper is to improve the speed of shopping using Radio Frequency Identification (RFID). In this shopping framework, RFID tag is utilized for realization of the items, enhancing the security and the speed [2, 3].

II. RFID

Radio-frequency identification (RFID) is a technology that electronically records the presence of an object using radio signals. It is used for inventory control or time sporting events. It is designed to work on the industry standard carrier frequency of 125 kHz. It is not a replacement for the bar-coding, but a complement for distant reading of codes [6,7,8]. This technology is used for automatically identifying a person, a package or an item [6]. This system provides an automatic identification method, relying on storing and remotely retrieving data using RFID tags or transponders. An RFID tag is an object that can be attached to or incorporated into a product for identification using radio waves. Chip-based RFID tags contain silicon chips and antennae. In this paper, we have developed a smart shopping cart system that allows customers to manage their shopping list while shopping and only pay the bill at the checkout counter [5, 6].

RFID is widely used in a variety of applications for real time data capturing and few of them are listed below [3]:

1. Logistics & supply chain visibility
2. Attendance tracking

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3. Library Systems
4. RTLS (Real Time Location System)

There are many advantages of RFID over Barcode [10,11]. They are listed in the following table:

Table 1: Comparison between RFID and BARCODE

Parameters	RFID	BARCODE
Ability to read and write	It can read, write and alter	It is read only
Line of sight	Not necessary	Necessary
Durability	High	Low
Rate of reading	Multiple tags at once	Single tag at a time
Security	High	Low

III. SYSTEM OVERVIEW

The desired system should be reliable while scanning the products, consistent in providing right responses to the operations and also properly send all the details to the online database [3,6]. This paper proposes a smart trolley system that allows customers to scan the products and complete the billing process in the trolley itself. The customer has to take the trolley and scan the products. If the customer wants to remove any item from the cart, he has to re-scan it [12,13,14,15]. Once all the products are scanned, the customer should proceed to the checkout. Here, the payment can be made using online apps and the customer can also check the balance or transaction details on the website of the shop. [8].The following figure depicts the flow chart for billing process. After scanning the card, the system checks for customer or admin. If customer is detected then the customer can purchase any item, check balance or double tap to return any item. If admin is scanned, the options are to add a new customer, recharge customer card or check balance.

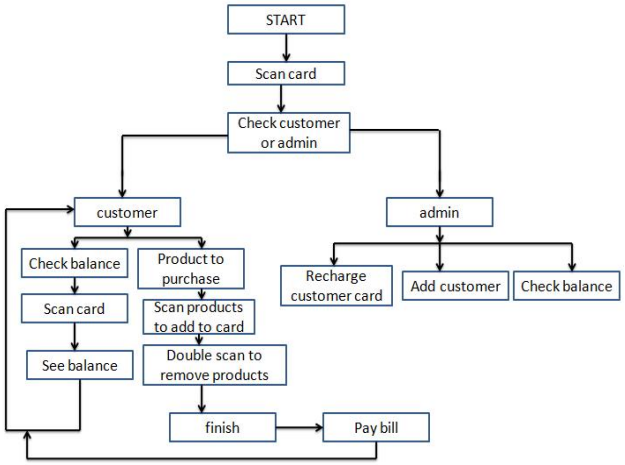

Figure 1: Flow chart for billing

IV. DISCUSSION ON PROTOTYPE

This section deals with the hardware specifications, results and discussion. Hardware model is made ready for the smart trolley. The hardware components used for this project include RFID, Arduino UNO, EM 18 RFID Module, 16x2 LCD Display, Buzzer, Red LED, Green LED, Female to female jumper wires, Female header pins and bread board. The specifications of RFID include model YR9010. Its dimensions are 120x85x20mm. It works in the frequency range of 902 MHz- 928 MHz or in the range of 865MHz-868MHz, voltage of 3.5V-5V and the output power will be in the scope of 0dbm-26dbm. It can read up-to 50 tags/sec. Its reading capability varies from 10cm-3m depending on tag, antenna and implementation. It has a communication baud rate of 115200bps(default).The Arduino connection model is shown in figure 2.

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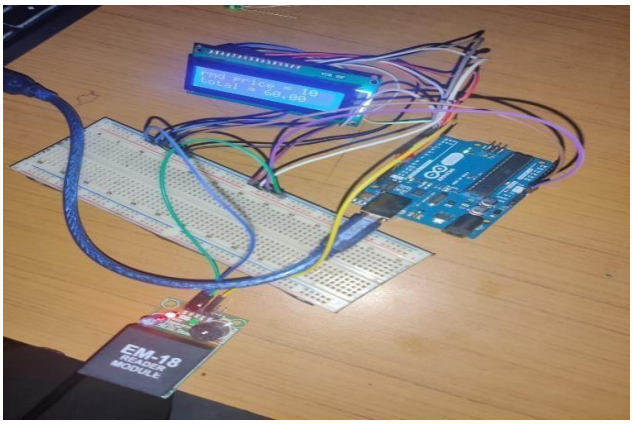

Figure 2: Arduino connection model

Using this Arduino connection model, the final hardware model containing the connection and cart is shown in figure 3.

Figure 3: Hardware model

The hardware model can be used as a smart shopping cart.

V. ADVANTAGES AND APPLICATIONS

Smart shopping has many advantages over traditional method of shopping [16,17]. The advantages include the following:

- Develops the shopping experience of customers in stores
- Minimizes the shopping time
- Each time when item is added, the customers will know the total cost and number of items in the cart. Therefore, customers know when they cross their estimated budget.
- Reduces the checkout time for the customers.
- Reduces the man power at billing sections

VI. SECURITY ANALYSIS

The security of the system is very important. There are five security parameters detailed below:

- ***Confidentiality*:** In each communication between the smart cart and the server, the message sent from the smart cart to the server is encrypted using the smart cart's public key. The message sent back to the smart cart is encrypted using a session key, which is only known to the server and the client [19]. Therefore, no outside adversary will figure out the data in the communications. This implies that the privacy in the smart shopping system is well-protected [20].
- ***Integrity:*** The message sent from the smart cart to the server is signed with the smart cart's private key S_a thereby protecting the integrity of the system. When the server sends the message back to the smart cart, it

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creates a MAC (Media Access Control) using the information shared with the smart cart S_2 and no outside adversary will be able to modify the message while passing the check of MAC thereby protecting the system [20,21].

- ***Replay Attack Resistance***: In the proposed system, all communication messages include a time stamp T, that makes hard for an attacker to perform a replay attack. If a malevolent customer replays a message from a server that contains an item's price lower than current price, the smart cart can detect that the message is replayed immediately by checking the time stamp. If the time stamp T in the message is not consistent with the system time, the message will be discarded.
- ***One-Time Key:*** Every time a smart cart requests information from the server, it randomly creates a pair of session keys and sends them to the server. The server uses one key to encrypt the data and the other to create a MAC. The session keys are generated for each request and are unrelated to the previous keys. By adopting the session keys, the data sent from the server to the smart carts is well protected.
- ***Tag Security:*** Based on the design, physically destroying the tags or blocking the RFID signal from a tag can be detected by the scales on the smart cart. A small camera will also be installed on the smart cart to cooperate with the scale for this function. If the smart cart fails to read a tag and the camera detects that a new item is put into the cart, it will activate an alarm. Any modification of the RFID tags will be detected by checking the HMAC (Hash-based Message Authentication Code), that cannot be forged by any outside agency without the secret key. Also switching the tags on different items does not work because peeling off the tamper-proof tags will break them [19,20].

VII. CONCLUSION

In this paper, introduction to smart shopping cart was discussed. Smart shopping is done using RFID and Arduino UNO. The hardware model was designed such that the customers could pay the bill themselves online without waiting in queues near billing counter. The advantages and applications of smart shopping over traditional shopping are significant. The security analysis is also possible by Confidentiality, Integrity, Replay Attack Resistance, One-Time Key and Tag Security.

In the near future, this system can be further improved by providing face recognition in place of smart cards. Using this, all the details are stored online with the customer's face as identity. This makes the customer shopping very easy by just purchasing the items using the trolley. There is no need of customer's smart card [22]. The bill will be sent to customer's e-mail id and an amount will be deducted directly from the customer's bank account. Nevertheless smart trolley can be enhanced in security aspect by providing the consumers privacy by guaranteeing secure online transaction [23].

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