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IoT Based Efficient Smart Shopping Cart Using Radio Frequency Identification (RFID)

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Abstract

In the age of technology, the term IoT (Internet of things) rapidly used in the past few years, forming a smart environment by connecting several objects having communication capabilities over the internet. IoT has large implementations in different fields of everyday life, but here we contemplating shopping malls, that are pondering as a rushed place after shopping. People have to wait at billing counters in long queues that make the shopping process hectic. Wastage of time and resources is also another problem. In the proposed work, the smart shopping cart system will provide ease to customers in shopping and billing, using radio frequency identification (RFID). The shopping mall will have a mobile application containing all the products of the shopping mall, the customer will generate the required item list by using a smartphone. The RFID tag placed on all products when the customer picks any product and placed it into a smart trolley RFID reader that is installed on a smart cart will fetch all the information (Price, MFG Date, Expiry Date) about that product from RFID tag. The customer will continue adding products in the trolley and the bill will be displayed on an LCD screen located on the smart trolley. When customers will be done shopping, will pay bills through E valet or on the billing counter.

Keywords: RFID, IoT, smart shopping

1. Introduction

(IoT) applications bring a new revolution in the field of information technology. The Internet of things is increasing day by day and becoming a common thing. IoT enhances the comfort zone of humans. The Internet of Things is a very simple concept, it means taking all the things, physical objects in the world, and connecting them to the internet. IoT helps us in establishing a connection with various physical objects, electronic devices, and sensors, by this information and data can be shared without any need for human interaction. RFID (Radio-frequency identification) is used in several IoT applications. Radiofrequency identification system (RFID) is an automatic technology that helps machines or computers to identify objects, record metadata, or control individual targets through radio waves (Hussien et al., 2020). RFID systems are consisting of the combination of a reader and a tag. RFID used radiofrequency waves to capture and store the information from the RFID tag. In recent years, RFID technology is widely used in different fields such as education, business, industry, and healthcare. The RFID system can be used in real-time systems and is very well suited for Internet of Things (IoT) Applications (Sinha et al., 2019).

In E-commerce also, RFID steadily becomes more common. With the use of RFID, it is easy to track the product, arrival time, and to check the location. It provides better customer services before and after shopping. For the unique representation of all products in the market, RFID technology is more efficient and easy to use, forming a smart environment.

The problem that we are going to address in this article is, a shopping mall is a place where we can find almost all the necessities of life. Because of these facilities shopping malls are considered as rushed areas especially the queues at the billing counter and the billing process itself is more hectic. Constant improvement is required in the traditional billing system to improve the quality of shopping experiences for the customers (Joe, 2017). As this is the technology era shopping malls are now equipped with the latest technologies that make the shopping and billing process easier. But still, a huge work is required to overcome this hectic time-consuming problem.

The purpose of this research is to propose a smart shopping system that simplifies the process of shopping. We proposed an IoT based Efficient Shopping Cart using Radio Frequency identification. This might be done by simply attaching RFID tags to the products and attach an RFID reader with an LCD on the shopping cart. Customers will have seen the product price and other detail on-screen after scanning. Products on shelves can easily locate with the help of notification by using a mobile app that saves time. The app will be linked with the device that is installed on the cart. The cart is also equipped with a payment terminal for online billing through credit cards.

2. Literature Review

This paper aims to critically evaluate the different methodologies used in the smart shopping system. In this section, various papers include, in which new concepts and techniques are constantly introduced, therefore, it is necessary to critically analyze the recent trends of this literature.

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In this paper Kumar et al., (2019) designed a system for smart shopping using IoT. The proposed system provides a smart system to save time, to avoid the huge rush, and simplify the way of payment. In this system, the author uses different software and hardware to build a smart shopping system. The customer first login the system and create the list of item. After arrival in the store, the device will connect with the smart trolley using Bluetooth. In the end, the final checkout process will be available. The customer will pay the bill using Paytm. The drawback of this system is that customer cannot add the item if forget to add before the shopping.

In this paper Gunasagar and Balachander (2020) a smart billing system by using RFID and weight sensor where the purchase can be done very easily without waiting for a long time in queue for billing. The author suggests a framework that uses RFID based trolley that consists of smart labels or RFID tags that are used to transmit data to the RFID reader and also to PLP deck and on the other hand, it produces real-time updates. It makes the whole framework smart.

In this paper, Sahare et al., (2019) invented a system using RFID tags. The system reduces human interaction in the billing system and makes the shopping process easy with no additional time. The system consists of an Andriod app with an easy algorithm. The customer first logs in and search for the item using RFID tags. And can add or delete items after checkout the final list. The result will show on the LCD which will be b on the shopping trolley. The drawback of this system is the failure of hardware.

Laxmi, Alat, and Ajay, Chothave (2019) proposed a system in which customer didn't have to wait in the queue for a long time at billing counters and if the customer doesn't know about the details of the product such as price then they cannot predict whether their shopping is under budget or not. The automatic billing system was attached to the trolley and implemented using machine learning algorithms and RFID technology while frequent itemset generation algorithm was used for sales promotion. This can be the first smart trolley offline retail system, which will recommend products to customers based on the products dropped in the trolley.

Shopping from a supermarket is a tedious process because of the increasing number of customers. Shopping process became more time consuming especially long queues at billing counters. In the proposed system (Naveenprabu et al., 2020) smart trolley helps the customer in shopping. The trolley has an electronic billing system. To use this smart system customers must have an Android application. This smart shopping system includes RFID Tags, WIFI, Bluetooth Protocols, IoT, and LAN. The proposed shopping trolley system works with an ultrasonic sensor that helps to achieve obstacle avoidance. The system also follows the customer with the help of Bluetooth that is connected with the customer's mobile phones. RFID tag reader helps to generate the bills. The smart trolley helps the customer by making the process easier, prices handled by the admin, and the customer interacts with the trolley by using the mobile app.

In (Shahroz et al., 2020) the authors proposed a system to solve the problem in the supermarket where the customer needs to wait in a long queue at the billing counter for bill payment. The smart shopping trolley was proposed which consists of RFID sensors, Arduino microcontrollers, Bluetooth modules, and Mobile applications. RFID tag was attached to each product and RFID reader reads the product information through the RFID tag. After this, each product information shows in the customer's mobile application. Then shopping information sends to the server wirelessly and bill generated automatically. Customers can log in through the mobile app and can also view the shopping details that make shopping more easy and efficient.

Shadan et al., (2020) proposed an IoT based smart shopping system that can be used in shopping malls to overcome the problem of waiting in long queues at the payment counter. The proposed smart shopping trolley consists of an RFID reader and an LCD system. RFID tag was attached to very products. Customers scan every product and drop in the trolley. The RFID reader sends data to the central server database from where the product details were retrieved by an LCD of the shopping trolley and on the billing counter. The customer needs to just pay the amount at the billing counter or via an e-cash wallet.

In markets, the main problem is to locate the products that customers want. A shopper is also worried about the total amount and billing process. Another problem is that shopper has not information about sales, discounts that are available in a particular mall. In the proposed system (Mekruksavanich, 2020) a smart shopping trolley system using RFID technology, the smart shopping trolley automatically identifies the items placed inside the trolley and adds in the bill. It simplifies the process of shopping through the use of an RFID device that is installed on the shopping trolley to assist shoppers with purchasing activities. Before placing the products on shelves all data about items entered in the shopping trolley scan the item using an RFID tag reader and display it on the screen. Customers will find items using the mobile app and will be able to purchase the desired item without any complex process.

In this paper Borse et al., (2018) compares different methods of smart shopping using IoT with RFID tags. In the QR code system, it is easy to use but the drawback of this system is to download QR code otherwise customers cannot shop. With RFID technology it is easy to manage the system but the disadvantage is the scanning process is small. In NFC it is easy to use and understand the system but the drawback is there is a risk of fraud in this system. Zig-Bee system is easy to use and very simple but to use this system customers should have the proper

knowledge. These systems require a QR code on the product. The author suggests replacing the QR system with bar code by using NFC, Zig-bee, and RFID.
The major drawback is stood by drawing a customer's line to pay the bill. The smart shopping structure that is brought avoids this drawback and has additional features to facilitate customers. In this proposed system (Mukesh et al., 2018) (I) raspberry PI radio frequency recognition is increasing rapidly and technology to achieve wireless communication with the server. The small tags in the RFID system are linked to the products. RFID readers wirelessly read the tag attached to the product to collect information about it, which may be related to some random data records. Thus, RFID systems automatically collect information about it by identifying items.
In (Lambay et al., 2018) the authors proposed an automated billing process with the use of automated billing trolley to solve the problem of shopping queuing and bill generation complexity which is a time-consuming process. The proposed shopping trolley consists of a barcode scanner by which the customer can scan the product and automatically the product details were stored in the Wamp database which can be fetched by the android app. The scanner will keep
the track of all products added to the trolley. Each trolley has a unique ID, an android application use this ID so that a user can access the billing information. A wireless smart-device makes note of all the scanned products of the particular trolley with allotment number and is linked with the backend database through the Wi-Fi module. The computer at the billing counter displays all the list of products added to the trolley and the final bill will be generated.
Joe, Nithin (2017) proposed the system for the shopping market where the cashier at the billing counter produces bills using a barcode reader which is a time-consuming process and results in long queues. To overcome these problems, an RFID reader with a touch panel display system was fitted with the trolley. When products were scanned with the RFID reader, the amount of the item was added to the purchase bill and is shown on the LCD attached to the trolley. Once the products were added, the cost was added up and all of this information was sent to the computer for billing through a wireless link, which makes the billing system faster and reduces overcome the problem of a long queue at the billing counter.
Sabarinathan (2017) proposed a system to solve the problem in a shopping mall where large crowds lead to long queues at the billing counter because the cashier has to scan every product for billing purposes. To solve this problem the automated shopping trolley makes note of all scanned products placed in it. The trolley was linked with various devices such as barcode scanner, Raspberry Pi, LCD, load cell, buzzer, switch module, and database. It facilitates the customer to self-scan the products which the customer wants to purchase. The Automated shopping trolley implementation is easy, very economical, and will reduce the time required at the billing counter.
Sainath et al (2014) proposed the system for shopping malls where the billing process is very time- consuming and requires maximum manpower in the billing section, and yet the waiting time remains quite. The automated shopping trolley was proposed which consists of a shopping trolley with barcode scanners and a Battery kit to allow users to self-scan the purchased products. A wireless smart- device make note of all the scanned products of the specific trolley with allotment number and was linked with the backend database. Therefore scanned products were automatically billed in the wireless smart device for their purchases. Hence time-consuming work of scanning and billing every product can be avoided.
Hussien et al (2020) featured a system to provide a service for blind people so that visually impaired people can shop independently, without assistance from others. “Shoptalk framework and visually impaired route framework” enables visually impaired individuals to shop independently and to seek out their way in a shop or store. Smart Shopping System with RFID Technology Based on IoT facilitates blind peoples to find their location within the shopping mall and also the locations of things he/she needed to buy.
Most of the time customers have to face problems as for patchy information over the product, on sales time, and wait at billing counters. The customers need continuous improvement in the billing system to improve the quality of the purchasing experience. To overcome these issues described above and to improve the current system, in this proposed system [17] builds a smart trolley using RFID. This can only be done by fixing the RFID tag to the product and RFID reader with the LCD on the shopping trolley. With this system, customers will have information about the price of the scanned item, also briefed about the total price of the item and the product. The system will save customers time. Some promising challenges in the shopping system are highlighted in this section that needs to be addressed. In the proposed system, a new method describes that may help to sort out these issues.

3. System Architecture

Fig 1: Describes the overall architecture of the proposed system. The following components are playing a key role in the successful implementation of the system.
1) Cloud Database Server: Cloud Database Server is an online database in which data about each product, its location, and quantity is stored. In short, a relational database of products is made. It also holds the information of customers.

2) Smart cart: Smart cart is the combination of IoT components and a shopping trolly. Description of IoT components is as follows:
Microcontroller: Microcontroller is acting as a centralized controller for other components like RFID reader, LCD, and Bluetooth module.

- LCD Display: LCD which is embedded in the trolley is used to display product information.
- RFID reader: RFID reader scans the products and sends the RFID to Mobile Application.

3) Mobile Application: The customer has an android application that is connected with smart trolley using Bluetooth technology, to transmit the product information in real-time. Mobile App also has a barcode scanner that scans the barcode embedded on the cart.
4) Payment API: This system allows users to pay through credit card, Application is connected to the payment API which ensures the secured transaction processing system.
5) Cashier/Admin System: At the counter, A POS System is installed to validate the orders and transaction, if payment of a specific customer is not done yet, or the customer is unable to pay through credit card, then an alert to the POS system will be generated with all details and total price, and customer's manual payment will be collected and recorded.

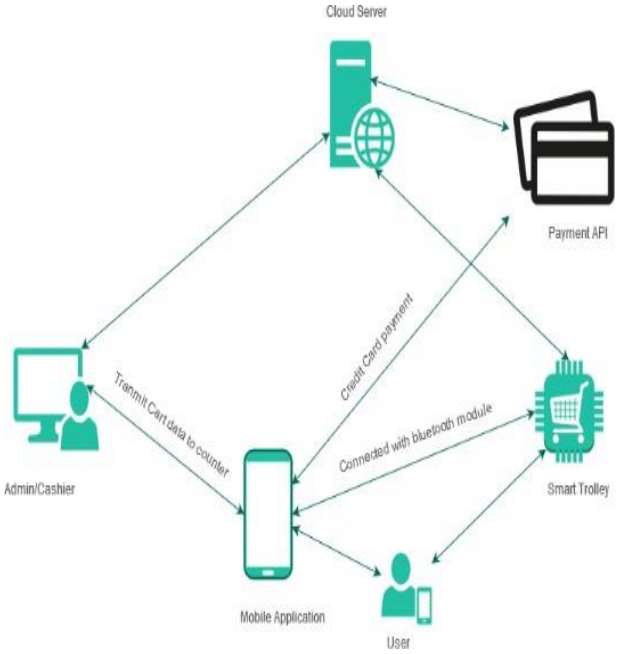

Fig 1: System Architecture

4. Methodology of System

The system conforms smart shopping by using smart shopping cart and e-payment. Detailed working and process flow is described below which will elaborate on the working of the system and its behavior during the whole shopping process.
First of all, the customer enters into the shopping mall and collects the shopping cart. Shopping cart has embedded QR code which is scanned by the customer from the smart shopping app. The customer can only scan the data when he is logged in. After scanning the QR code, customer's unique ID and shopping cart ID will be sent to the database server.
When a customer picks up an item that item will be scanned by the RF-ID scanner and the details of the product will be sent to the mobile application by using the Bluetooth module then details of the product will be displayed on the Android application. The customer keeps on adding the products and a list of the products is made in the application. All the items in the shopping mall have a unique RFID TAG. The data about the items is already stored in the database.
A comparison of scanned is made with the RFID stored. If RFID is matched with the RFID stored, then the details of the product will be displayed on the Android screen as well as on the LCD screen which is embedded on the smart cart.
In case if the customer wants to delete or remove an item from the list, he or she is asked to rescan the product and the product will be removed from the cart.
After clicking the finish button, the customer will be asking for the payment option. There are two options for payment first one is e-payment and the second one is manual payment.

In the case of e-payment, the customer is redirected to the payment page where he enters credit card details and other relevant details required. After validation, the total price will be deducted from the debit card or credit card of the customer, and payment successful message will be displayed on the application. In the meantime, the system sends an acknowledgment to the cashier that the payment is done for the specific cart.
In case the customer selects the manual payment option the system generates an alert in the cashier system containing the information about the customer and the specific cart.
And the customer will be asked to pay at the counter. After successful payment at the counter, the cashier system will send the acknowledgment to the server for the specific transaction.

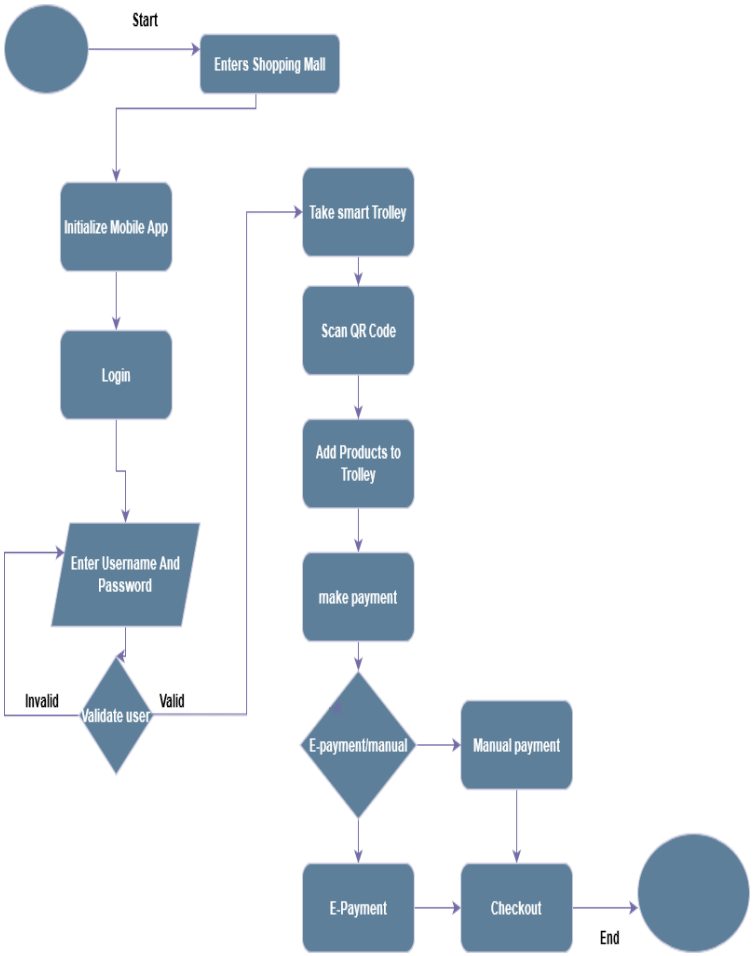

Figure 2: Flow of the system

5. Conclusion

The smart cart system will help as well assist the customer in shopping. The system will overcome the long queues at the billing counter that is a wastage of time. It will also reduce unnecessary manpower. The proposed system will improve the shopping experience. All the products containing the RFID tag and that tag will be scan by RFID reader placed at the trolley, fetching all the details of the product and generating bill at is being displayed at the LCD screen on the cart. If customer pick any product placed it in the trolley and then bring it back its price will deduct from the bill. The proposed smart cart system helps and assists the customer in shopping it also overcome the queue problem at billing counters and saves time. This system also provides the facility of online payment using the mobile app at the time of shopping. All the products containing RFID tags that are being scanned by RFID reader placed at the trolley, fetching all the details of the product, and generating bill at is being displayed at the LCD screen on the trolley. If customer pick any product placed it in the cart and then bring it back its price will deduct from the bill.

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