

Smart Shopping System based on Flutter, RFID and Bluetooth

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Abstract—We all have spent a lot of time standing in long queues in stores waiting for our turn when we only wanted to buy one small product, or when we have a lot of items and we have to wait for them to get scanned one by one at the counter and then the bill to be generated. Mobile applications are a great way of automating a manual process by providing a user-friendly interface and an efficient system which makes the shopping experience of the customer better. Internet of Things refers to a system of various devices connected over the internet which can then transmit and receive data between themselves and create a smart environment. The proposed project leverages these technologies to create a system in which the customer can use the mobile application to scan the barcode of the products that they want to buy, then checkout to pay the automatically generated bill online and simply walk out of the stores without any hassles. A RFID + Bluetooth module is also proposed which will keep track of the customers entering and exiting the store and to make sure that a customer doesn't leave without paying for the items they have bought.

Index Terms— Internet of things, RFID, App Development, Smart Systems, Barcode Scanning and Retail.

I. INTRODUCTION

Time is money, and all kinds of industries are now moving towards increased digitization and automation because they make the processes more efficient and secure. In India, since demonetization, the use of digital payments has increased multi-fold. Now, everyone from roadside hawkers to expensive showrooms accept various forms of digital payment methods. Also, with the breakout of the Coronavirus pandemic, the world is moving towards doing all the work without direct human contact.

A. Concept Proposed to be Employed

Amazon recently started a new line of physical stores called "Amazon Go" where you have to scan the QR code at the entrance of the store, and then simply pick up the products that you want and walk-out of the store without any hassles. The store builds up your virtual cart as you pick the items and charges your Amazon account when you exit the store. Taking inspiration from this, I have designed a mobile application using Flutter which a person can use to scan an item that they want to buy. The scanned item gets added to their virtual cart and after taking everything, the customer can simply checkout on the app itself and pay the generated bill. The barcode scanner uses the ZXing scanning library to scan the barcode. A separate RFID-Bluetooth module is also proposed using Arduino which tracks the entrance and exit of the customer. This solves the problem of waiting

in long queues in stores when you just want to buy one or two things. It also makes the whole process contactless and digital.

B. Technology Employed

Flutter is a Software Development Kit (SDK) created by Google to make mobile applications with intuitive and beautiful user interfaces. It is written in Dart language, which is a hybrid of the traditional C++ and Java languages. One of the biggest advantages of Flutter is that we can create both Android and iOS apps with a single codebase, without having to code the same thing twice for both platforms. Flutter is the best alternative to create MVP (Most Viable Product) apps and for prototyping because it's fast.

Firebase is a backend service provided by Google, which can be used to implement various backend functionalities like authentication, database management, API creation and serving and hosting. Since both Flutter and Firebase are created and managed by Google, it is very easy and advantageous to use them together for creating the UI and the backend of an application. In this research work, we have used Firebase primarily for database management, which stores all the items that are present in the store with their necessary details like barcode number, price, quantity and stock. It also stores all the orders made by a customer in which we can see the items the customer bought, the total amount and the details of the payment transaction for the convenience of the customer and the shopkeeper.

To track the entry and exit of a customer from a shop we have used RFID technology. RFID or Radio Frequency Identification is a wireless technology that uses radio waves to transmit signals and data between a transmitter and a receiver. Using this technology, we can track when a customer enters a store and if they have made the payment for the items that they have bought before leaving the store.

For creating the RFID tracking module prototype, we have used the Arduino Uno microcontroller with the RC522 RFID Module and the HC-06 Bluetooth module. The RC522 module consists of the receiver which can detect a customer entering or exiting the store. The Bluetooth module is used to connect the microcontroller and the RFID module to the phone, so that the payments can be tracked.

The barcode scanning inside the mobile app is based on the ZXing ("Zebra Crossing") Library which is a barcode scanning module written in Java.

II. RELATED WORK

A. RFID Based Smart Shopping: An Overview

This paper suggests an innovative concept of smart shopping and billing system by installing several hardware units on the shopping cart. The main idea is to provide the customer with a more efficient, technology oriented and feasible shopping experience. All these units use the RFID technology to share and display information like the total amount, track cart location, display the inventory etc. RFID tags are used to identify products whose data is stored in a central database. A prototype was developed and successfully tested for the above enhancements [1].

B. Internet of Things Based Smart Shopping Cart

Based on the idea of providing a fast and easy shopping experience to the customers, this paper also suggests a physical smart shopping cart which enables the user to scan the items on their own and just simply pay the bill afterwards. The shopping cart consists of a RFID reader to scan the product put in the cart by the customer. It also consists of a NODEMCU module which communicates with the central server and stores the details of the products that are scanned by the customer. A 16x2 LCD screen displays which product is added or removed from the cart and the total bill after the addition or removal [2].

C. Innovative Cart for Smart Shopping

This paper proposes an Android application which can scan the items picked by the customer and create a virtual bill which is then displayed at the counter. Once all the products are scanned, the customer can go up to the counter and make the final payment. The application also provides other features like checklist creation, viewing of offers and checking the availability of the products in the store. The proposed system, however, doesn't provide a completely automatic and no contact experience as the customer must go the cashier to pay the final bill [3].

D. Smart Shopping System Android Application

To eliminate the time taken at the billing counter and to increase customer satisfaction, this paper proposes an android application which uses the NFC scanner built-in the smartphone to scan the products. The phone is

connected to the server through Wi-fi, the server receives the details of the products and calculates the total bill for the customer [4].

III. MOTIVATION

Every time I went to buy groceries from stores or clothes from a retailer, I had to stand in long queues waiting for my turn to get my products scanned and pay the bill. This is a very common problem faced by us that we have to stand in long queues, wasting our precious time when we just one or two products to buy. While thinking of projects to do in my final year major project, this problem inspired me to work on the proposed smart shopping system.

I wasn't sure where to start, so I started reading about how the shopping experience can be enhanced. This is when I came across the Amazon Go Concept [5]. They are physical stores started by Amazon, that use technologies like computer vision and artificial intelligence to build up virtual carts for the customers, after they're done picking up their products, they can simply walk out of the store without having to wait in any queues. This inspired me to create a system of my own, which enables the customer to scan their own items and pay online without waiting for anyone else, and simply walk out of the store.

IV. PROBLEM DOMAIN

The work proposed in this paper relies on technologies like cross-platform mobile application development and wireless technologies like RFID and Bluetooth, and how these technologies can be used to provide better experiences to people in their everyday lives.

Mobile applications are one of the best ways to provide people with solutions to problems faced by them in their everyday lives. There is a plethora of apps available online – from ordering food online to trading stocks while sitting at your home – that solve real-world problems and make the lives of people much easier.

The proposed research in this paper couple mobile applications with wireless technology to provide an enhanced shopping experience to people who don't like or don't have the time to wait in lines.

V. PROBLEM DEFINITION

The total expenditure done by the average consumer is increasing every year. Along with this, the increased urbanization and population makes it imperative to do away with the existing system of cashier billing and to introduce a novel and ingenious system for supporting this increasing change effectively.

People nowadays live life in the fast-track and do not have a lot of time on their hands to wait for trivial things like get their products billed and then pay the amount. The proposed system can prove to be an extremely cost-efficient and user-friendly way of enhancing the user shopping experience in grocery and retail stores globally.

VI. STATEMENT

A shopping system realised with the help of technologies like Flutter, RFID and Bluetooth, that does away with the traditional cashier shopping system and gives the customers the ability to scan their items on their own and pay the auto generated bill without standing and waiting in any lines.

VII. PROBLEM FORMULATION

The problem that we are trying to address through this research work is essentially the traditional cashier-based shopping system. In the current system, a customer has to first pick all the items that they want to buy, then they have to take it to the counter where the cashier will scan all their items and then the customer will pay according to the calculated bill.



Figure 1: Current Cashier-based Shopping System

There are several inefficiencies in this system: -

1. The queues at the counter are usually very long.
2. Sometimes, the cashier is not present at the counter, which wastes the precious time of the customers.
3. There is contact between the customer and the cashier, which is not desirable in today's world.

4. If a customer wants to add more items after the billing has been done, they will have to stand in the queue again.

VIII. PROBLEM SOLVING

A. Proposed System

The proposed system's main element is a mobile application that lets the user scan an item that they want to buy and add it to their cart, after they have scanned all the items they want, they can simply checkout and pay their auto-generated bill and move out of the store. A RFID-Bluetooth hardware module is also proposed to that tracks the customer's entry and exit from the store and verify that the customer has made the payment for the items he has bought.

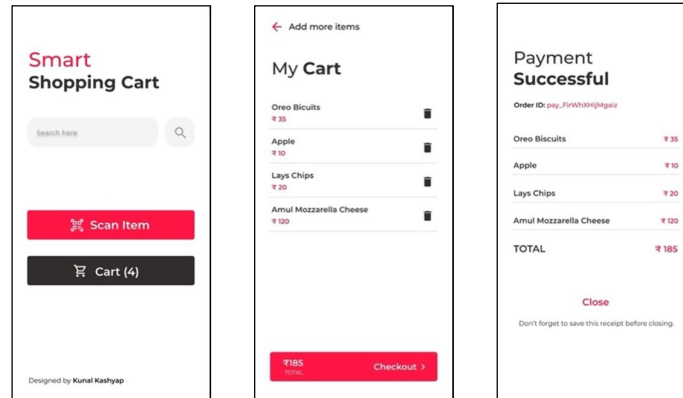


Figure 2: Mobile Application User-Interface

B. System Working and Design

Each customer will have a RFID transmitter which will transmit a signal that will be received by the RFID receiver when a customer will enter the store. This will log the entrance time and details of the customer. Once inside the store, the customer can open the proposed mobile application on their Android or iOS devices and simply pick an item from the store that they want to buy and scan it using the mobile application. Once the item is successfully scanned, the app fetches the product details based on the scanned barcode of the item and displays it on the screen for the customer to confirm if they want to add that item in their cart or not. This way the customer can choose to add the product to their virtual cart and once they are done adding all the products, they can view their cart with all the products that they have added can also choose to remove a product that they no longer wish to buy.

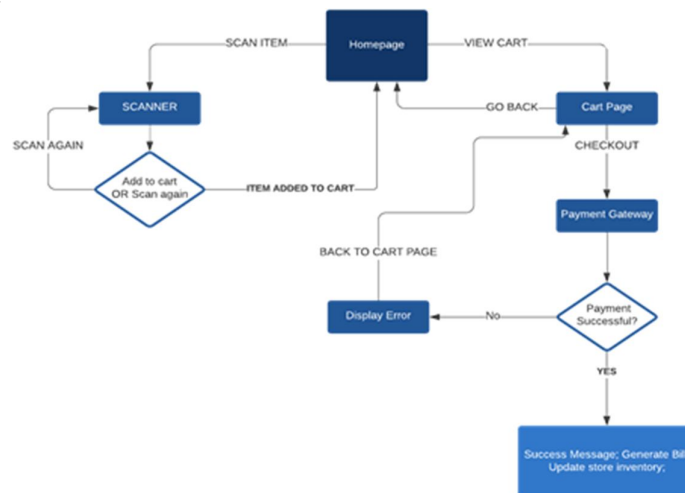


Figure 3: Smart Shopping System Design Flow

Once the cart is finalised, the customer can easily checkout on the app and pay directly using all online payment methods. After the payment is successful, an electronic bill is generated for the customer with all the details of the payment and the items that they have bought, for their reference. After this, the customer can simply walk out of the store without having to wait in any lines or have contact with any of the shopkeepers. The RFID receiver will again receive a signal from the transmitter on the customer's exit and will log the exit time and details of the customer.

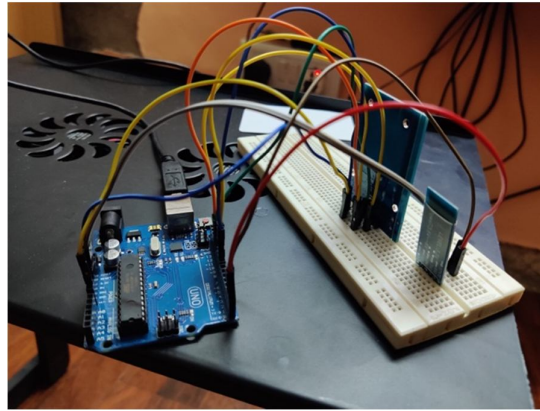


Figure 4: RFID and Bluetooth Hardware Module

C. Innovative Content

There are a few things that make this work innovative. Firstly, it's a completely non-contact and digital solution to replace the current cashier system. At no point of time from entering the store to leaving the store after buying all the items, does the customer have to encounter any person of the store or wait in any lines. This also eliminates any waiting time that there might be as the mobile application gives the customers the ability to scan items and pay the final bill, and the wireless RFID module tracks the customers' entrance and exit, and the payments made. Using Flutter is also very beneficial over traditional app development technologies as it helps us to make an intuitive and easy to use app very easily and it gives us the ability to make the app for both android and iOS devices with a single codebase.

IX. CONCLUSION

The proposed system was successfully implemented, and the desired objectives were achieved. The developed product is an extremely efficient and economical alternative for the current stand in queue shopping system. The Flutter mobile application along with the RFID hardware module aim to potentially change the shopping experience of all the customers at big retail and grocery stores. The project showcases the complete application and explains the proof of concept and the working of the system, but there are a few aspects that can be included to make the system even more efficient and secure. By comparing the calculated weight of the items in the virtual cart to the actual weight of the items carried by the customer, we can ensure that the customers don't bypass the system and pay less than what they should. Secondly, by creating an account, we can give the users a way to add money to their virtual wallet from where the money can be deducted automatically when they checkout in the application, without having to go through the complete online payment process.

FUTURE WORK

We can improve the security of the system to make sure that the customers pay the complete amount of all the items that they are buying and are not duping the store. One way this can be implemented is by calculating the total weight of all the items a customer adds in the cart. This can be easily calculated as the weight of the product is stored in the database, so when a customer scans the product and adds it to their cart, its weight will get added to the total weight. Once the customer makes the payments for all the items in the cart, he will have to show the weight of all the items he is carrying at the exit, to tally the actual weight of all the items to the calculated weight based on the virtual cart. If the actual weight comes out to be more than the calculated weight, then it will mean that the customer is carrying more items than what he has paid for. Another feature that can be added to the application is giving the users the option to make their own accounts so that the money can be deducted

automatically from a virtual wallet linked to the account. In the current application users have to pay the auto-generated bill after they are done shopping. Creating an account for the user will allow them to visit their previous orders in one place and more importantly, we can link the user's credit cards or other payment wallets to this account for auto deduction of the bill amount, without the user having to checkout and pay the bill. This will make the process even more efficient and secure.

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