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Smart Shopping using QR codes for Bill Calculation and RFID system

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Abstract - *Most of us have spent what seemed like forever in a retail store, waiting for the person in front of us in the queue to bill a large number of items, when we just needed a loaf of bread or a single shirt. Long lines at the cashier counters can cause people to wait for a significant amount of time, before they can pay for their products, and leave, regardless of the number of items being purchased. We feel that this can be changed, and our idea is to automate the check-out process, enabling automatic payment, striving towards a new-age digital shopping experience. We propose to do this by using a smart phone application that allows the user to scan the products he or she wishes to purchase, generate the bill for all the products scanned, make the payment and simply walk out of the store. This process will ensure easy customer, inventory management and finance handling, making both management and customer happy. This application will help avoid long queues and provide a hassle free checkout. It will not only reduce the amount of waiting time, but it will also reduce or eliminate the need for a cashier. In addition to this, in accordance to today's trend of e-transactions, the entire process will be free of any hard cash.*

***Key Words*: QR Code, Smart Shopping, RFID, RFID Reader, Bluetooth**

1. INTRODUCTION

The idea for the project is to optimize this process of shopping at a retail store, by enabling the customer to handle the check-out process. The approach to automated shopping and billing until now has been more hardware-centric. A number of attempts have been made to design Smart Shopping Carts with various different functionalities. Awati and Awati [1] developed a design that focuses on obviating the need to drag heavy trolleys and to automate the process of billing, not taking into account cases of deception, if any. Yew et al. [2] describes a system for smart shopping that replaces the traditional barcode by RFID tags and scanners. In 2013, another approach to use Wireless Sensor Networks to design a cart where the entire processing was done at the cart locally and a camera acted as a barcode scanner was proposed [3]. Most other related work also uses RFID based shopping trolleys interacting with various sensors. Our approach is to provide a better shopping experience for the customers by saving their time, minimizing the man-power required at the shopping mall, while also significantly bringing out the cost of operation by eradicating the need for complex hardware and allowing a user to shop using just their smart phone, while allowing the retail store to track customer purchases.

We propose to do this by using a smart phone application that allows the user to scan the products he or she wishes to purchase, generate the bill for all the products selected, and make the payment. Instead of using traditional bar codes, we propose to use Quick Response (QR) codes to identify each product. The application includes an option to search where a product is located in the store. The entire process of bill generation is automatically carried out, and is displayed on the interface as the user continues shopping. Once all the items are scanned and the user confirms the purchase order, the final bill is generated and the user is be redirected to payment options. The customer has the option to sign up for a custom wallet that can be used for faster payment.

In addition, to further ease the shopping experience, we propose to use Radio Frequency Identification (RFID) to identify when a customer enters the store. RFID is a method for Automatic Identification and Data Capture (AIDC). Each customer has a unique identification card, with an RFID tag that sends their information. This is read by an RFID Reader and processed by the microcontroller, tracking a customer's entry in the store and authenticating the phone application for use via Bluetooth technology. This application will provide the user an overall better shopping experience, as it will help avoid long queues, an easy method to find particular commodities in a large store, as well as remove the need for a cashier and will make the transaction itself automated and hard cash-free.

2. DRAWBACKS OF EXISTING MODEL

We believe that the current system of shopping at a retail store has seen little change and our proposed model can help enhance the customer shopping experience. Customers have to wait for painfully long durations during the checkout process, irrespective of the number of items they are checking out of the shop. This is especially true when the people in front of you are counting their cash or coupons at an unbelievably slow pace and during discount sales. The billing process at a shop is the most tedious part of shopping, and we believe this can be eliminated. Also, when you are in a large store for the first time, finding a specific product can be a tedious task.

Moreover, retail stores traditionally make use of barcodes to identify each product as well as in their membership cards. In terms of data storage, bar codes can hold less data, mostly numeric, and take up greater space as they are one dimensional. Also, if a bar code is damaged or dirty, they are not capable of reading any data and they cannot be properly scanned.
We believe that the entire system can be changed to provide a better shopping experience for the customer, as well as for the store management, through digital solutions.

3. PROPOSED SYSTEM

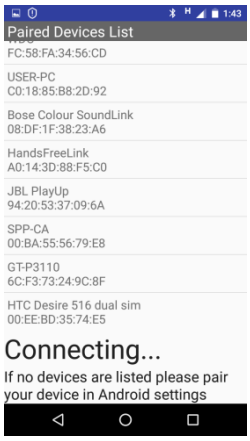
We propose a system that has a mobile application, which can be downloaded onto any smart-phone, in conjunction with a RFID authentication system to completely digitalize the shopping process. We propose to use QR codes to identify the products in the store, instead of barcodes. As QR codes have three positions and detection patterns, they can be read faster and from a greater distance, allowing faster checkout. As they are capable of storing data both horizontally and vertically, they can store the same amount of data, in lesser space than a bar code. Additionally, QR codes can hold multiple data types like numbers, symbols, texts and control codes. Thus, in a large store, it would mean a significant decrease in the storage space required. Also, when damaged, the QR can still be scanned, and can recover over 30% of the data, making it superior in terms of data restoration. The proposed system components are detailed as follows:

3.1 Smartphone Application

The smart phone application is one that provides a User Interface (UI) to interact with the products, by means of adding, viewing or removing it to a personalized cart.

The customer can access the smart phone application for shopping once they have been authenticated via Bluetooth. The application uses a QR code scanning feature that accesses their smartphone camera and allows a user to pick up a product, scan its QR code and thereby add it to the cart. The UI display updates with the current product's details and the total bill auto-increments. The UI also has the option to select an item and remove it from the cart.

The application is also able to tell the users which section of the store a particular product can be found in. This enables the user to quickly find what he or she is looking for and bypasses the hassle of standing in long queues to get their items checked out. In addition to this, there is also an option to pay using wallet for registered members. Once they log in, if their balance is sufficient, the bill amount is deducted from their wallet; else they are redirected to other payment options.



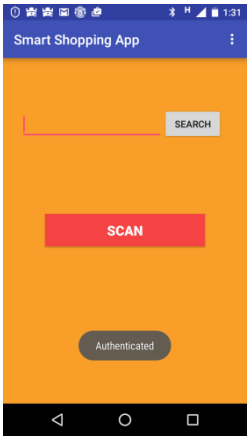


Fig-1(a): Authentication of application via Bluetooth

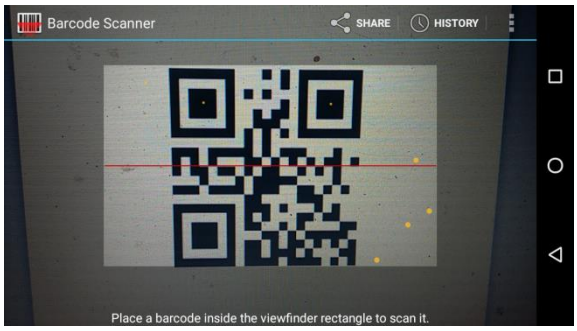


Fig-1 (b): Product QR Scanning

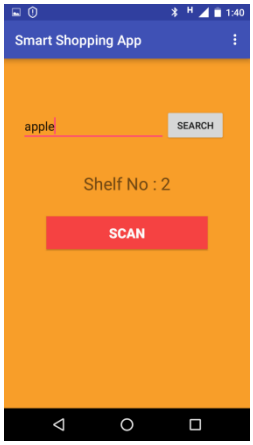


Fig-1 (c): Search Option

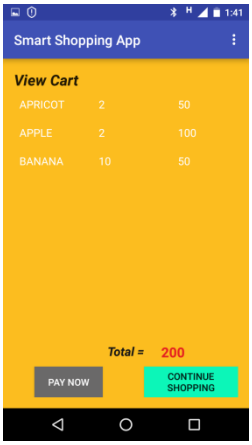


Fig-1 (d): View Cart

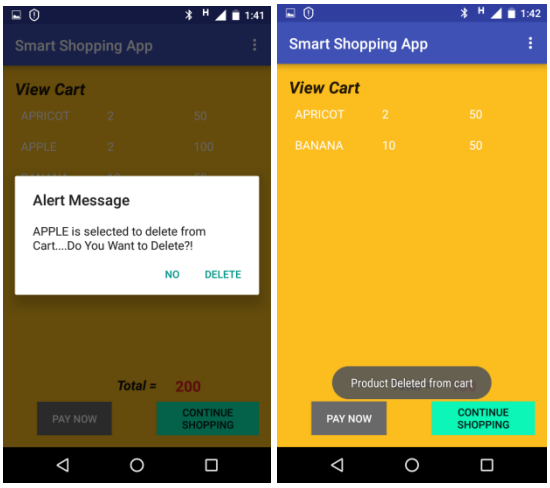


Fig-1(e): Delete from Cart

3.2 Hardware Module using RFID

The RFID system is implemented to further improve the speed of the checkout process, as well as provide a better shopping experience to both the user and the store management. It consists of a microcontroller as a central unit that is connected to a RFID Reader and a Bluetooth module. A card embedded with a RFID tag is used for authentication of the user. The card is scanned on entry and enables the mobile application using Bluetooth technology to authenticate the app for shopping. Retail stores currently use custom cards with bar codes to identify registered members. The advantage of using RFID over bar codes is that RFID does not require line of sight for communication, which means a customer, need only walk in close proximity to the reader and will be authenticated.

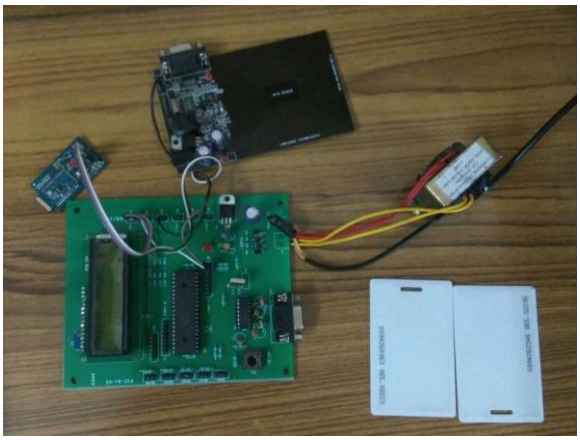


Fig-2: Hardware Set Up

4. SYSTEM DESIGN

Following are the architecture diagrams of the two components of the proposed model.

4.1 Smartphone Application

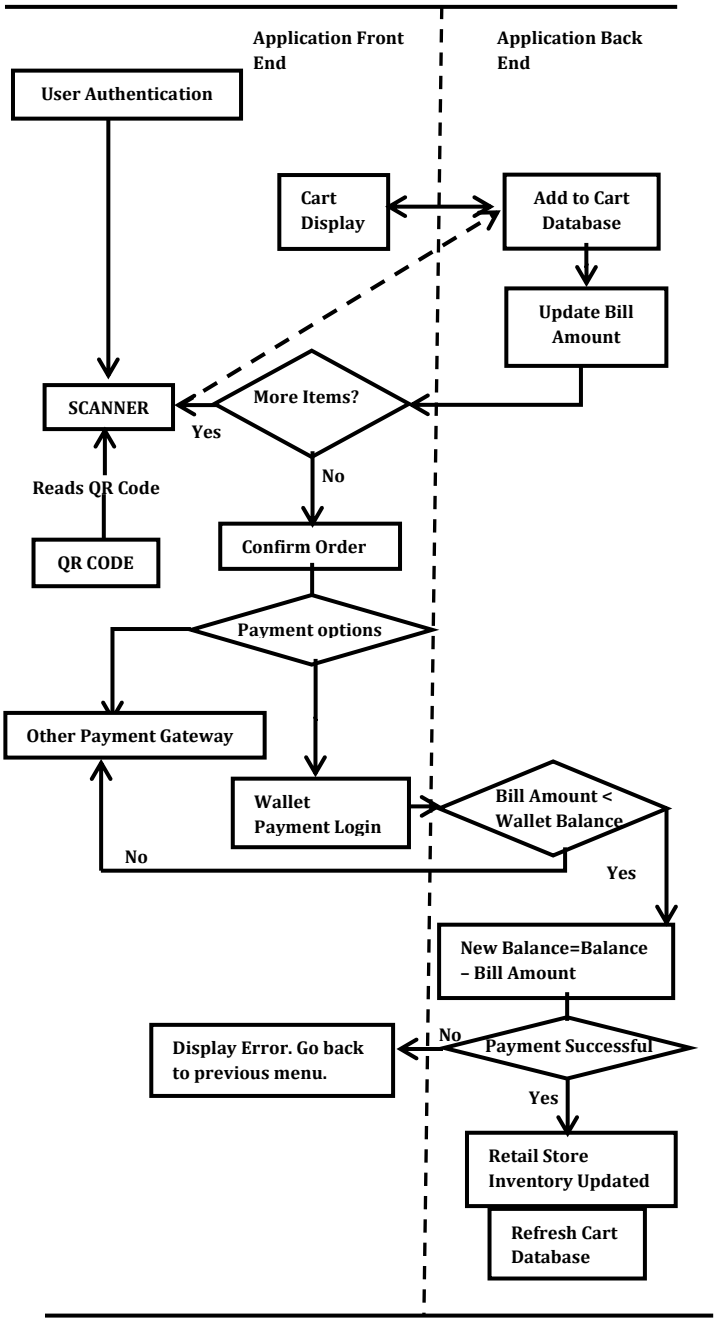


Fig-3: Software Flow Chart

4.2 Hardware Architecture

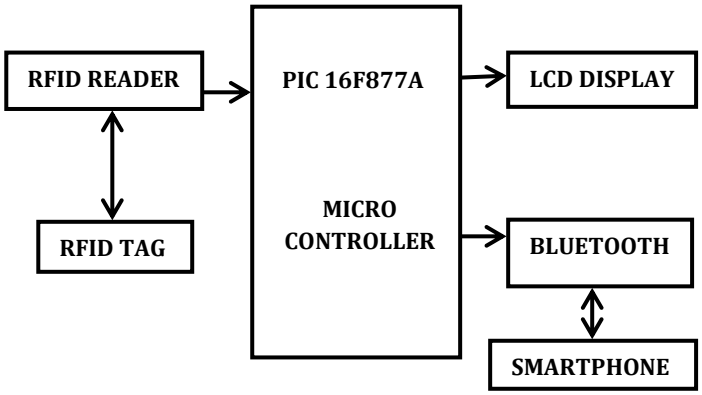


Fig-4: Hardware Block Diagram

5. IMPLEMENTATION DETAILS

A prototype has been made based on the above design. The smart phone application was developed using Android Studio. It makes use of the Zebra Crossing (Zxing) scanner [4] that allows the application to access a user's smartphone camera for scanning the QR Code. The current implementation considers a retail store system that has a set of sample products with QR codes. The hardware components used are as follows:

1. PIC16F877A Microcontroller and Printed Circuit Board (PCB) that is designed to use the microcontroller as a control unit. It allows serial communication through Universal Asynchronous Receiver Transmitter (UART) protocol. The microcontroller uses a 5V DC supply and the output can be displayed on a Liquid Crystal Display (LCD) screen.
2. RFID Reader is used to interrogate RFID tags and contains a Radio Frequency module, which acts as a transmitter and receiver of radio frequency signals. The transmitter has an oscillator that creates the carrier frequency, a modulator that adds data commands to the carrier signal and an amplifier to enhance the signal so as to awaken the tag. The receiver has a demodulator to retrieve the data, along with an amplifier to boost the signal for further processing.
3. RFID Tags: 2 passive RFID tags have been used for the prototype. They have an encoded number, one of which is authorized to use the phone application, while the other is unauthorized. A passive RFID tag does not have a battery; the power is supplied by the reader. When it comes in range of the reader, radio waves from the reader cause the coiled antenna within the tag to form a magnetic field. This field powers the tag, energizing its circuits, allowing it to send the information encoded in its memory.
4. Bluetooth Module: This module also requires a 5v DC supply. Bluetooth UART enables wireless transmission and reception of serial data. Devices equipped with Bluetooth technology support wireless access to mobile phones, over a distance. The Hc05 module used for the prototype has default password 1234.
5. Power Supply block consists of a step down transformer along with other components present on the PCB, namely, bridge rectifier circuit, input filter, voltage regulators, Output filter, indicator unit.
6. LCD Screen is used to display the output from the hardware.

6. CONCLUSION

We believe that this process of shopping can revolutionize the existing shopping system, as it isn't a very high cost investment for the store management. Almost everybody owns a smart-phone with a camera which is all that is required to perform the software automation that we propose. In exchange, the speed of shopping and the convenience that the customer gets is immense. This leads to a win-win situation where the customer is happy to come back for the convenience that this system provides, and the management is happy with the customer retention they get.

Additionally, the scope of the idea is immense, when used in conjunction with prediction algorithms. By keeping track of the data that the application produces, stores can use data-mining to customize the entire shopping experience to each and every individual, by means of showing the customer personalized messages based on their buying patterns. Also, it could use prediction to prompt the user to what he or she might have forgotten to purchase in the visit to the store.

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