“Transforming Shopping Carts into Smart one Using Radio Frequency Identification (RFID).”

INTRODUCTION To IoT

COURSE PROJECT REPORT

Submitted by :-

Mohd Meeraj - 201000031
Ritesh Kumar Verma - 201000043
Kishan Gopal Mishra - 201000018
Bhavya Alok - 201000010

Dr. Shyama Prasad Mukherjee International Institute of Information Technology, Naya Raipur

July-2021

Abstract:

Today, when we enter a big shop/mall/supermarket , how often do we have to stand inside long queues that usually end up taking as much time as we shopped for!. In Our research problem we aim to remove these waiting times, our proposed solution? RFID based Trolley/cart integrated with a mobile app.In our proposed solution , instead of an employee on the billing counter scanning the product bar codes , the consumer will carefully place the product which has a RFID tag on it , inside the trolley which has a RFID reader on it. The reader will register the item and through processing and communication methods that include Arduino and Bluetooth the information will be sent to Mobile app, after shopping is done, consumer can press on the pay bill button to redirect to popular payment methods(including cash at billing counter).By using the proposed solution the customer will be able to save a lot of his time and that may attract more and more people to shop offline again which will ultimately benefit the solution deployer.

Introduction :

Radio frequency identification system (RFID) is an automatic technology and it has machines or computers to identify objects, record metadata or control individual targets through radio waves. A typical RFID system consists of tags (transmitters/ responders) and readers (transmitters/receivers). The tag is a microchip connected with an antenna, which can be attached to an object as the identifier of the object. The RFID reader communicates with the RFID tag using radio waves. The main advantage of RFID technology is the automated identification and data capture that promises wholesale changes across a broad spectrum of business activities and aims to reduce the cost of the already used systems such as bar codes. Although RFID technology was discovered many years ago, it has advanced and evolved only during the last decade since cost has been the main limitation in all implementations. RFID is one of the big opportunities in information technology or in IOT, which will change the world broadly and deeply. When the RFID readers abided by appropriate communication protocols are connected to the terminal of the Internet, the readers distributed throughout the world can identify, track and monitor the objects attached with tags globally, automatically, and in real time, if needed. This is the so-called Internet of Things (IOT).

Population of the world is growing very rapidly and this is increasing the crowd in shopping complexes. Shopping is the activity in which a group of people unites at one place for purchasing products. So the shopping malls or supermarkets are facing a serious problem now-a-days that people have to wait in long queues for barcode scanning of their purchased products which is time consuming and uncomfortable, this is negatively affecting the human morale and may cause misunderstandings or conflict amongst people, for instance, when someone breaks the line and stands in front of other people. The supermarket also needs to provide comfort to its customers. Due to this problem people are attracted towards online shopping which will decrease the sales of shopping complexes. But due to higher risk of fraud, lack of inspection, item may not work properly or it may be defected, or transaction from stolen credit card people feel safe in traditional shopping. People enjoy doing traditional shopping, they feel more valuable, entertain by traditional shopping. In these types of situations, shopping complexes and traditional shopping have to reinvent to survive in today's scenario. Since shopping complexes are the place which is connected to various businesses, there must be some steps taken so that the businesses can grow.

There were many technological revolutions in traditional shopping. Many supermarkets are using barcode technology, Zigbee, RFID(for security purposes not for generating bills), wireless sensors, etc. In the current scenario Barcode is used in many supermarkets. Barcodes are continuous black lines and each barcode contains some specific code or data, when a barcode reader reads the barcode then it generates the information about the product. Barcode contains very small information inside it and it is only readable, not rewritable. Barcode readers can read only one barcode at a time and it needs a man to do so. It can easily be hacked. But RFID can not be easily hacked and a survey suggests that barcode readers can scan 10000 items in 53 hours whereas RFID can read 10000 items in just 2 hours so RFID is much more advanced than barcode. We can attach RFID reader with Arduino in shopping carts which will read the product's information when it comes in its range i.e. 5cm and with the mobile app we can easily see the information of the product and by totalling the amount bill will be generated automatically, this will make the shopping process very comfortable, easy and interesting. By mobile app users can locate the exact location of the product using data collection and customers can also filter the components based on IoT. The application software initiates all readers and tags activities. RFID provides a quick, flexible, and reliable way for electronically detecting, tracking and controlling a variety of items. RFID systems use radio transmissions to send energy to a RFID tag while the tag emits a unique identification code back to a data collection reader linked to an information management system. Since the bill is generated automatically ,there will be no hacking activities like we have to face in barcodes. RFID plays a very vital role in the retailing process to manage products from the manufacturing to the Inventory and from inventory to the consumer.

The functions of RFID systems generally include three aspects: monitoring, tracking, and supervising. Monitoring generally means to be aware of the state of a system, by repeatedly observing the particular conditions, especially to detect them and give warning of change. Tracking is the observing of persons or objects on the move and supplying a timely ordered sequence of respective location data to a model. Supervising is the monitoring of the behaviours, activities, or other changing information, usually of people. The benefits that RFID offers to the shopping complexes, both to the production process as well as to the shopping process are traceability, flexibility, comfortability and security. When products come near the RFID reader in the shopping cart. The consumer can interact with product information. This information is extracted by mobile applications from backend databases stored in the server system. The consumer can also search for the desired product location in the supermarket via interacting with a static map of the supermarket. The main contributions of this report are :

- Shopping cart has RFID reader, Arduino board, Bluetooth device which are connected with Mobile Application which provides comfort to customers because now they don't have to wait in long-long queues for barcode scanning.
- The searching and shopping list management modules are added in Mobile Application which helps the consumer to find the location in the supermarket, to remember the shopping list and to manage the shopping list according to preference.
- The promotion module helps the supermarket to pro[1]mote the product and offer special discounts to the consumers that can enjoy different product promotions and discount offers.
- Wireless communication will provide flexibility to the shopping and supermarket management system.
- The backend supermarket management system facilitates the supermarket to personalize its shelves and products according to consumer preferences.

Objectives:

1. Saving time that would otherwise be wasted in waiting in long queues at the billing desk.

2.Reduce workload on staff during festive seasons.

3.Provide a streamlined and personalised experience for the customer using the mobile app.

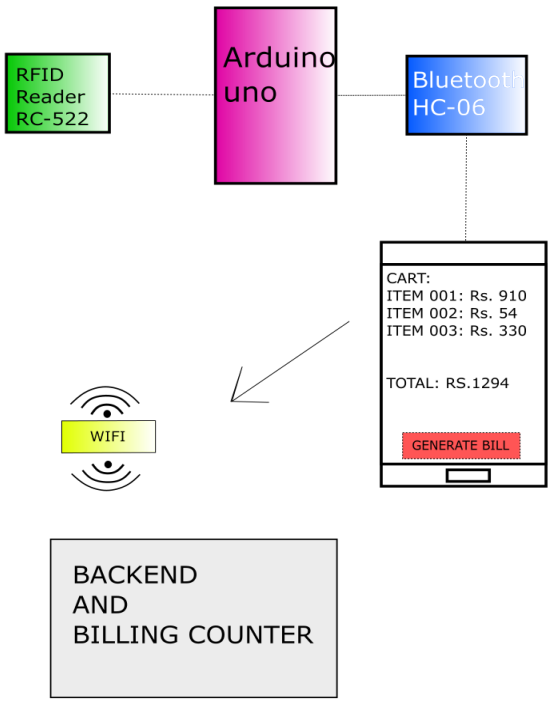
3. Proposed Methodology

Unlike in the existing scenarios , customers no longer need to wait in long queues outside the shopping counter, instead the customer just needs to put his desired item slightly carefully in the shopping cart/trolley so that the RFID Scanner registers the item.

This simple activity can save a lot of time for the consumers as the following process will happen automatically.

1. The item put into the cart will have its tag shared to a mobile application through the bluetooth.
2. Onwards some data will be recollected from this Tag number, Like
    2.1 item Name
    2.2 item Price
    2.3 Other miscellaneous info like discounts on items.
3. The Total price of all the items in the cart will be shown in the mobile app itself, and there will be a button that redirects the customer to a payment screen. (the customer can also pay at the billing counter in cash)

In this way the customers save a lot of time for themselves by not standing in a queue while someone else's barcodes are being scanned and their own items being scanned, all they need to do after doing all the shopping is to pay up.



The prototype of the the solution contains the following:

Hardware Components:

1. **RFID Reader:**

   The RFID readers aren't only capable of reading tags, but they can also write tags. These communicate with tags using 13.56Khz Electromagnetic field.
   RFID readers work on the principle of induction. The reader emits EM waves instead of the tag.

2. **RFID Tags:**
   a. The RFid tags are the units that store data inside them , they are of two types , active and passive. In our case we will be using Passive RFID tags as they dont need energy to communicate unlike active tags that require energy at all times.

3. **Bluetooth HC-06:**
   a. Bluetooth module as a communication module is perfect for the proposed solution as bluetooth HC-06 is low energy module and it will not require frequent battery replacements, also as the customer will always be just beside the cart while putting items inside it , the short range of bluetooth will not be a weakness but a strength in energy conservation.The bluetooth module will operate at the popular 2.4GHz frequency band.

4. **Arduino Uno:**
   a. Arduino uno is a popular (and easily available) microcontroller board which is based on the atMega328p chip on it.Developers can easily compile their instruction using the Arduino IDE which also makes it very easy for the instructions to be uploaded and executed.Arduino will work as both as a processing unit (to process data given by the RFID reader) and as a communicating unit (pushing the data to the bluetooth module for further communication)
   b. Alongside the following components the proposed solution also contains ***LED*** and a ***BUZZER*** which are turned on as soon as a item is registered by the RFID reader.These are to troubleshoot, as a customer might put in his item in the cart but if it fails to register , he knows that something went wrong.

SOFTWARE COMPONENTS:

Mobile App:

In IoT till now we needed communication modules to connect things with other things and processes to make them smarter, but in the modern world we can connect Smart things with People to make them even smarter.

The mobile app can be endlessly customised to put up with the needs of consumers and the owners of the shops/malls alike. The basic functionality it needs to have is to take in the data that is being transferred by the bluetooth module and process it using a customised database which itself can be endlessly customised by the deployer.

In the prototype of proposed solution the App is complemented by the following modules:

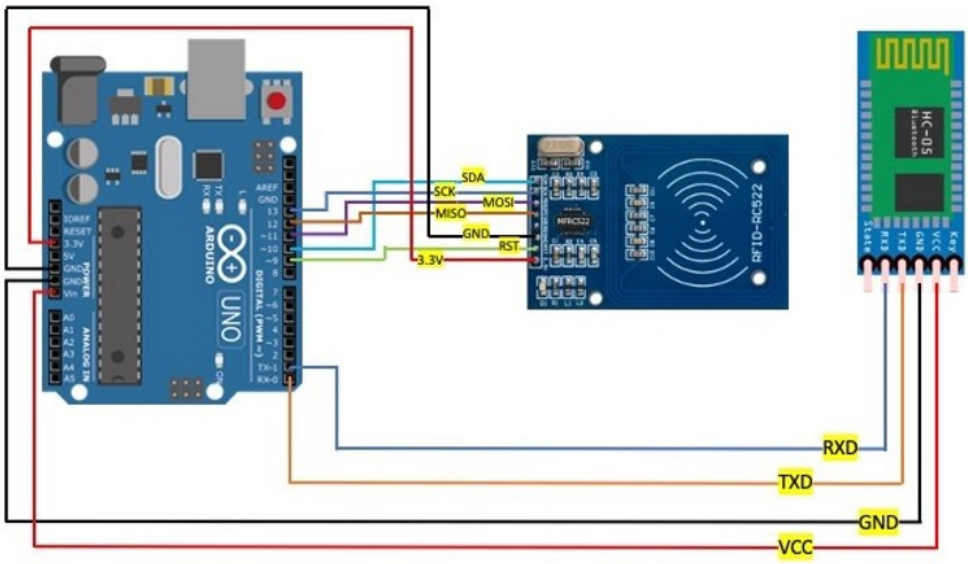
1. CART MODULE (main screen):
    a. This is the main module , the proposed solution contains the Sum of items inside the cart. On this customer should be able to see whatever is being scanned by the RFID reader as the customer is putting the item inside the cart in real time so that customer can feel satisfaction that something was indeed put inside the cart.
    b. This modules should also , at bare minimum, be able to remove the item that you just put by either showing an accept item/ reject item when you put inside the as the customer may go through a change of mind.

2. LOGIN MODULE:
    a. This module should be able to make the experience personalised. A sign up subModule is added for first time users.
    b. Data of Different login users should be stored differently so that the other modules' information doesn't clash.

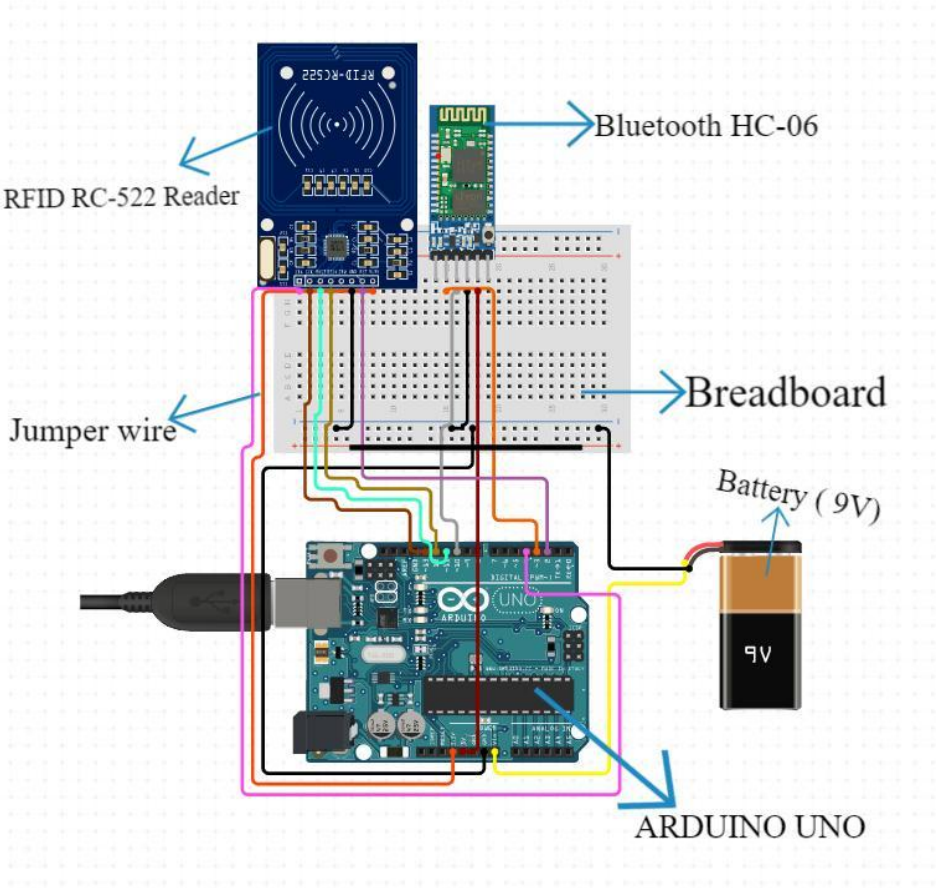
3. CONNECTION MODULE: This module is for connectivity of Bluetooth with the app , as there will be so many carts in the market , the App should provide a streamlined experience for connecting to your particular cart via the Bluetooth Module.

4. WISHLIST MODULE: The wishlist module should be a separate module so as to function like a grocery list type of wishlist , where a customer can add what he would like to shop before he goes to shop for the items in the shop. This module provides a streamlined experience as the customer will be able to remember and recall quickly what items he wants to shop for when he goes shopping.

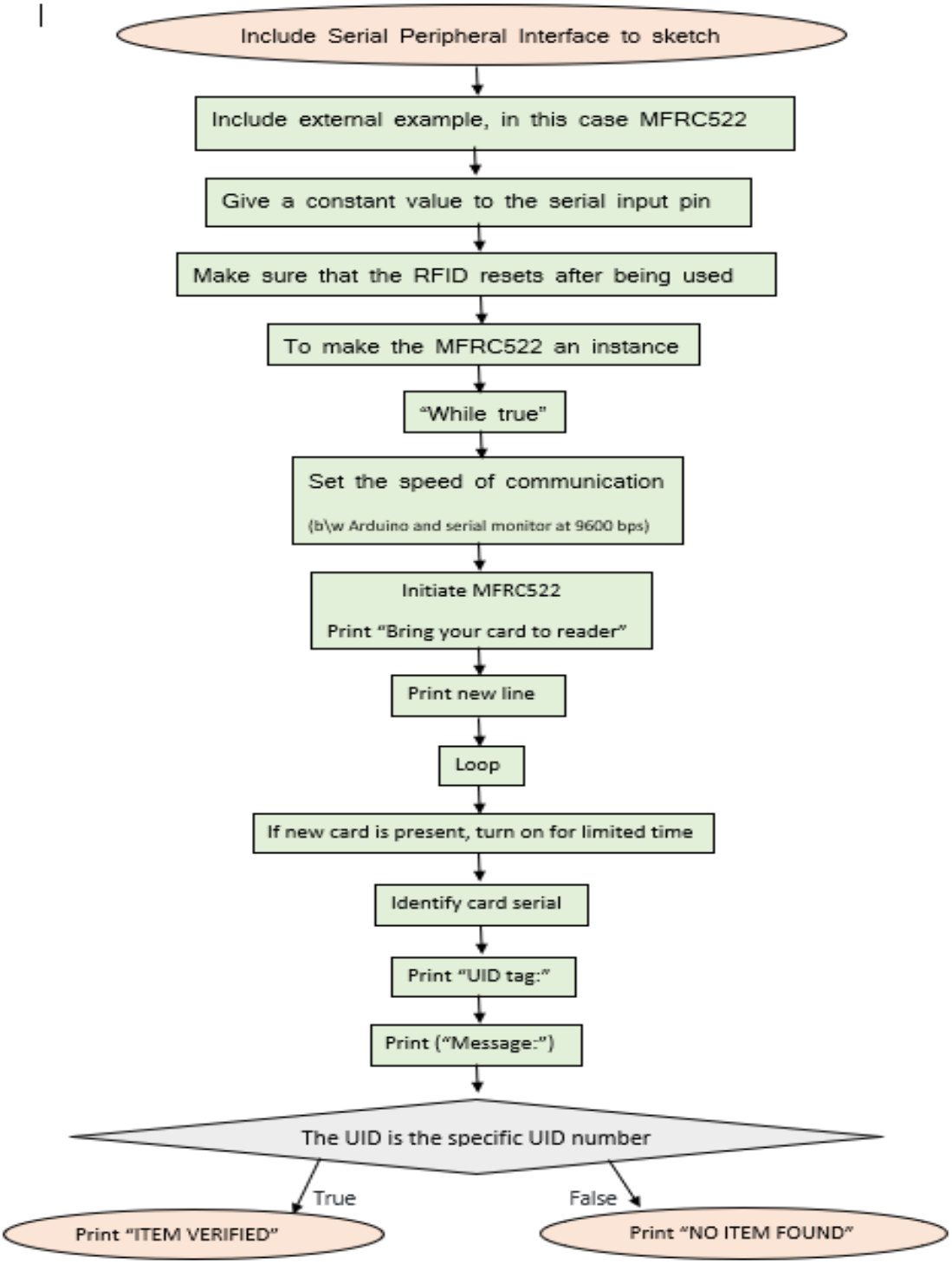
Interfacing Arduino with other major components



Complete Block Diagram of hardware components



Flowchart of Arduino Code



Workflow of Prototype

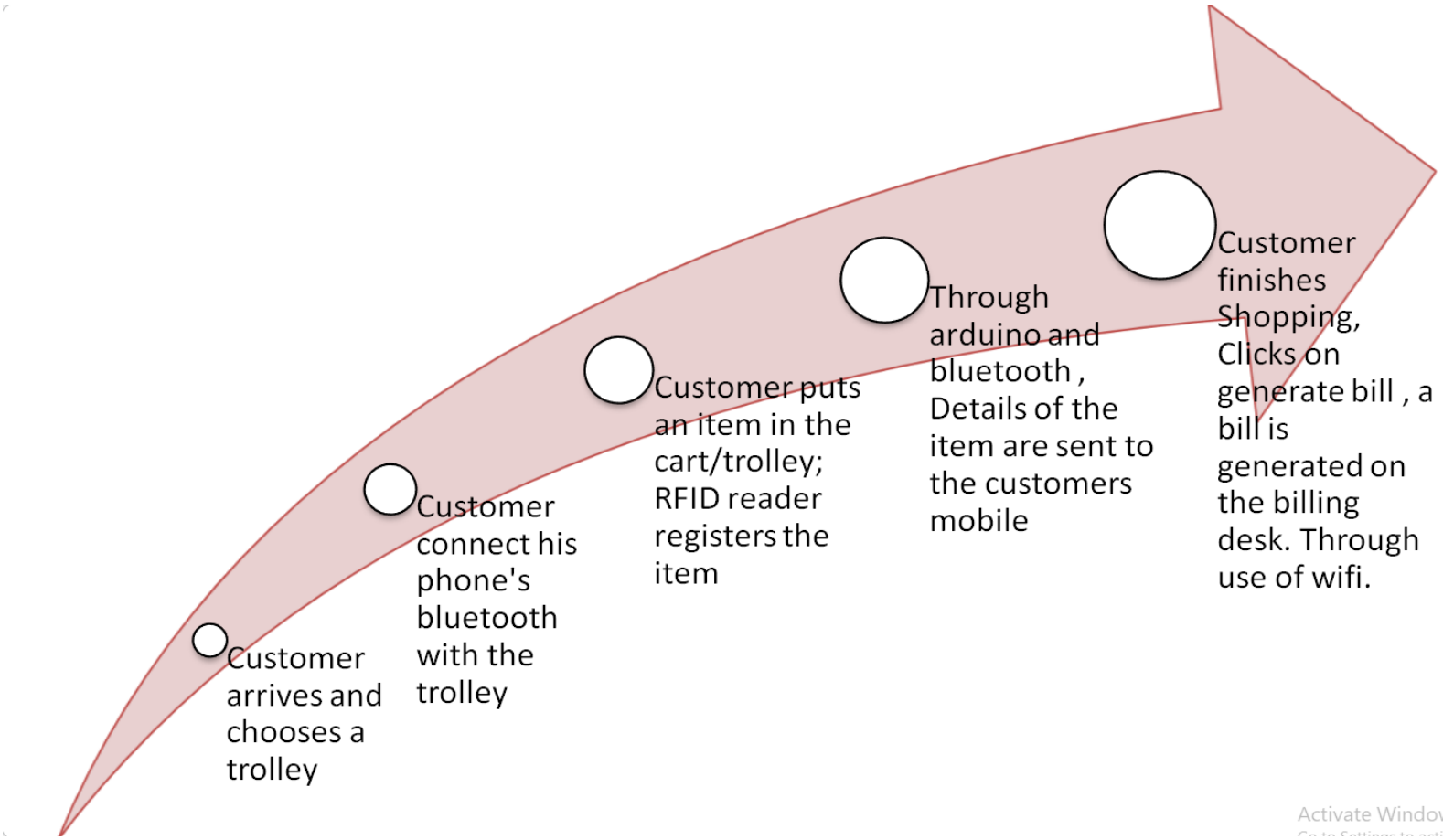


Fig : Explains the working of prototype

Step 1: RFID reader reads data from product RFID tag via RF Signals.

Step 2: RFID reader sends product data to Arduino Uno.

Step 3: Arduino Uno sends product data to Bluetooth.

Step 4: Bluetooth sends product data to Mobile App.

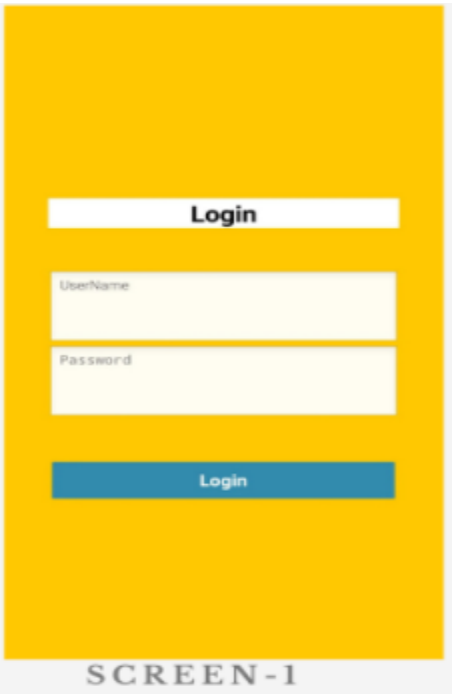
Results

Customers can login after the complete initialization of the android mobile application and RFID system. Customers can enter the username and password .

There is also a second method that is login with a user RFID card .The user RFID card is the passive RFID tag as we discussed in the electronic component section that contains a unique customer id. The customer id is the eight-digit unique numeric value stored in the RFID tag.When the RFID reader reads the customer RFID card, it sends it to Arduino Uno, then Arduino sends it to the android mobile application through Bluetooth and then the android mobile application gets the data from the server according to this customer id and verify it is a registered user or not. If the verification of customers is not successfully confirmed, then the customer can use the username and password option to enter manually into the system. The customers can also use a customer RFID card to enter into the smart shopping cart system automatically.

After login successfully, the customer became able to use different services in the dashboard discussed in the preceding section of the smart shopping cart to complete its shopping. The experimental prototype is shown in Figure below.

When the RFID reader reads the RFID card value then it sends to Arduino Uno which displays on serial monitor output that RFID properly sends it to the Android mobile application.



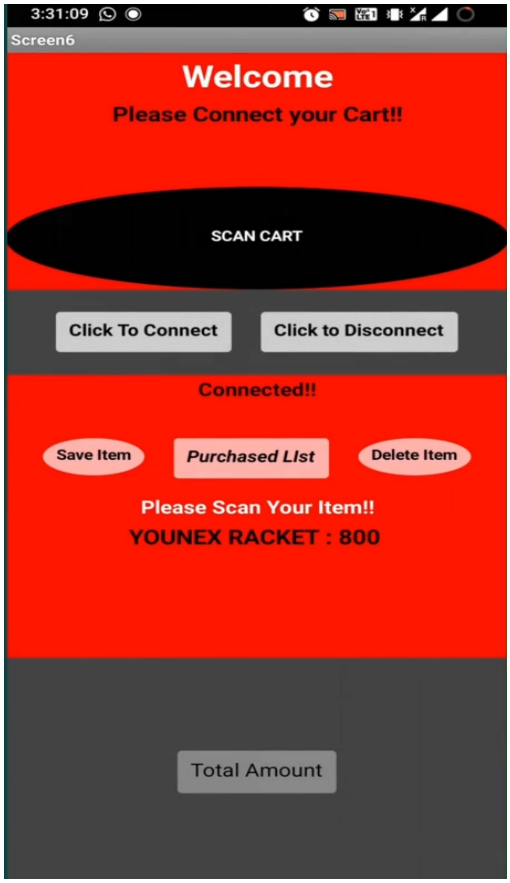
SCREEN-1

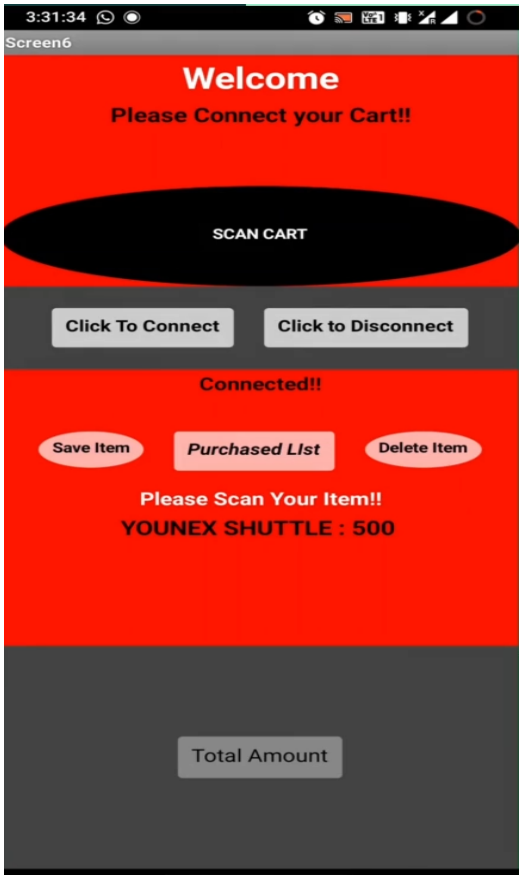
SCREEN-4

When a customer successfully enters into an android mobile application dashboard, an attractive screen displays in front of the customer.

The customer can enter into the search module which can be added to the prototype afterwards in which customers can see an indoor map of the supermarket. In this module, customers can select the desired category of the product, then the current location of the product displays to the customer on the map of the supermarket if it is available in stock.

After reaching the desired location, customers can pick the desired product and put it into the smart shopping cart. RFID reader reads the RFID tag of the product then the android mobile application fetches the data from the database according to this product RFID and displays product details to the customer on the mobile device. . The output of the serial monitor describes the results of the Arduino Uno which is working as an intermediary device s. The serial monitor shows the results of the product RFID that is scanned by the RFID reader and transfers it to the android mobile application as described in the RFID_Data_Transfer algorithm. Also, this scenario is shown in the figure below that displays how the product RFID is added to the shopping list. There is a Bluetooth module connected with Arduino Uno that provides wireless communication between the mobile device and Arduino Uno.





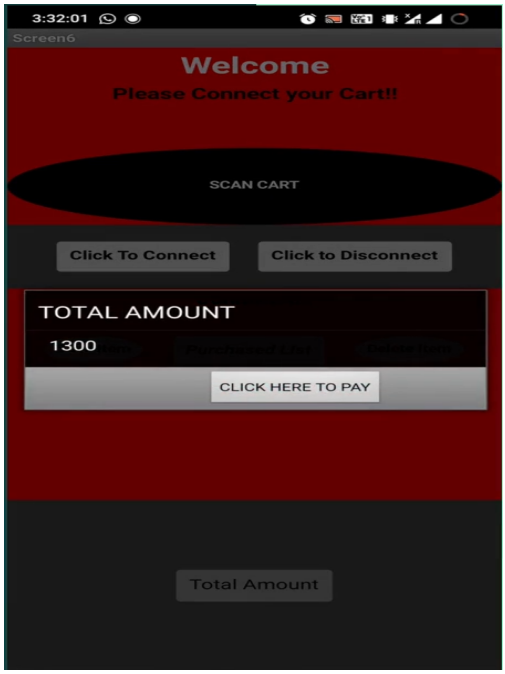


Fig : Above three figures Showing the process of scanning product and total amount

Some point to point results :

- RFID sensors with a shopping cart are proposed that are connected with Mobile Application to make the consumer get desirable products in the meantime.
- Wireless communication will provide flexibility to the shopping and supermarket management system.
- Prototype is extremely feasible to make as it is inexpensive and does not require too many components and also doesn't go through a complex building procedure.
- Some modifications can be made such as multiple modules such as location based searching module, promotion module, previous shopping history module along with sample bill generation for better shopping experience.
- Customers can check for availability of particular products by just sitting at home which we can't do in other existing systems.

Fig - Final prototype

Comparison of your solution with the existing solutions (Three bullets)

Existing system :

- Counter person needs to scan the barcode and it must be visible .
- The readability of barcodes can be impaired by dirt, moisture, abrasion, or packaging contours Short reading distance.
- Barcode does not have READ & WRITE capability

Proposed system :

- Automatic reading of RFID tag from product. RFID can be placed inside the product . No line of sight is needed.
- RFID tags are not affected by such conditions. Long reading distance.
- RFID tag having READ & WRITE capability

Conclusion

By means of this paper intent to simplify the billing process, make it swift and increase the security using RFID technique.
This will take the overall shopping experience to a different level. Different parameters such as the system parameters of smart trolleys like product name, product cost, product weight etc. are continuously displayed.
Thus with the help of the conclusion we can say that

1. Automatic billing of products by using RFID technique will be a more viable option in the future.
2. The system based on RFID technique is efficient, compact and shows promising performance.

This system is designed for automation of the shopping process by merging different technologies like Arduino Uno, RFID, and Android mobile application. That can be divided into two major categories Electronic components and Software components. In Electronic Components, Arduino Uno operates as an intermediary microcontroller, which controls the RFID technology and Built, communication between RFID technology and software components like android mobile application through Bluetooth module. In software components, there is an android mobile application in which customers login to the proposed system that can secure customer privacy.
Searching for the product in the shopping mall becomes easy because of the searching module based on product position allocation on the map which can be implemented after some development and deployment of the current prototype . Customers directly interact with the product information. This information affects the preferences of the customer about the product and helps them to get the best quality product. Shopping products can be displayed in a current shopping list of the customer that helps the customer to maintain its shopping list according to need or budget. That also helps to remind the remaining products to purchase.
Besides, there will be a server as a data center of the supermarket, which will also be connected with the smart shopping cart. When an android mobile application needs to extract data from the server, according to the customer RFID card for verification of the customer login or extract information of the product according to the product RFID tags, then the mobile application can communicate with the server wirelessly.

Learning outcomes

- Through this project we get to learn a lot about Arduino Uno , Bluetooth module, and RFID Reader and tag.
- We also got to learn how to make Bluetooth integrated Mobile Application.
- We also got familiar with MIT App Inventor.
- We learn how to code on Arduino IDE.

- We familiarised ourselves with the needs of modern industry and learned how to approach modern day technology requiring problems.

References

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Source code

```
#include <SPI.h>
#include <MFRC522.h>

#define SS_PIN 10
#define RST_PIN 9
MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.
int buzzer = 2;
int LED = 3;

void setup() {
  // put your setup code here, to run once:
  pinMode(7,1);
  pinMode(6,1);
  Serial.begin(9600);   // Initiate a serial communication
  SPI.begin();      // Initiate  SPI bus
  mfrc522.PCD_Init();   // Initiate MFRC522

  pinMode(buzzer, OUTPUT);
  pinMode(LED,OUTPUT);




}

void loop() {
  // put your main code here, to run repeatedly:

   // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial())
  {
    return;
  }

  String content= "";
  byte letter;
```

```
  for (byte i = 0; i < mfrc522.uid.size; i++)
  {
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }

  content.toUpperCase();
  if (content.substring(1) == "E7 1D 5B C9") //change here the UID of the card/cards that you
want to give access

  {
   digitalWrite(LED, HIGH);
   delay(500);
   digitalWrite(buzzer, HIGH); //tun buzzer
   delay(500);

   Serial.println("YOUNEX RACKET : 800");
   digitalWrite(buzzer, LOW);
   digitalWrite(LED, LOW);

   digitalWrite(6,0);
   delay(1000);
  }

  else if (content.substring(1) == "F3 F1 DB 1A") //change here the UID of the card/cards that
you want to give access

  {
   digitalWrite(LED, HIGH);
   delay(500);
   digitalWrite(buzzer, HIGH); //tun buzzer
   delay(500);

   Serial.println("YOUNEX SHUTTLE : 500");
   digitalWrite(buzzer, LOW);
   digitalWrite(LED, LOW);

   digitalWrite(7,0);
   delay(1000);
  }

}
```

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