Automated Shopping System using Smart Cart

Varad Pimpalkhute[a,*], Vaibhav Bhagavatula[*], Nilimay Nirbhik[*], Mayur Parate[*]

[*]Electronics and Communication Engineering, Indian Institute of Information Technology, Nagpur (IIITN), India.

***Abstract*—Nowadays, with the ever increasing population, there has naturally been a rise in the customers in shopping malls. This resulted in long queues at the billing desks. We thus propose a solution which would save both the customer's time and make the shop more user friendly. In this paper, we propose a model which automates the whole billing process by providing a customer with his own unique shopping ID and a smart RFID scanning cart. The customer will be able to view his shopping list on a web page hosted by the local server with the help of ESP 8266. Finally, while checking out, the customer will be directed to a payment portal, thus automating the shopping process and making it comfortable and user friendly.**

***Index Terms*—Arduino, ESP 8266, RFID scanner, web server, embedded**

I. Introduction

We have proposed a method for Smart Shopping. Today, it is very common to see long queues in most of the shopping complexes which makes purchasing a hectic and time-consuming task. We, therefore, have come up with this project on smart shopping which will make the life of purchasers as well as sellers comfortable. In this project, we have made a smart cart with the help RFID reader. Any customer who has come for shopping will press a button and his unique user ID will be generated. After that for any item he wants to purchase he will just scan it through the reader and his/her shopping list will be automatically updated showing the item name, quantity, price of each item along with the total price. Now, suppose he/she doesn't want to purchase something and need to delete that item from the shopping list he/she just needs to press one another button and scan that item, it will automatically be removed from the list. To see his shopping list he just needs to go to the website and enter his unique user id. Once he has submitted it, all the items, their quantity, price along with the total bill will be displayed. Then he can pay the whole amount online by going in the payment section of that website. This, therefore, reduces the time and energy spent in the queue and makes our task of purchasing easier.

A. Introduction to ESP 8266

The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers. The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community. This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. These are some raw modules of ESP8266 Module.

- ESP-01
- ESP-05
- ESP-12
- ESP-201

These are some Development modules of ESP8266 Module.

- NodeMCU V0.9
- NodeMcu V1.0
- Wemos D1 Mini
- Wemos D1 R2
- LoLin V3 NodeMcu Board

B. Introduction to Arduino Uno

It is a microcontroller board developed by Arduino.cc and based on Atmega328. Arduino Uno is a very valuable addition in the electronics that consists of USB interface, 14 digital I/O pins, 6 analog pins, and Atmega328 microcontroller. It also supports serial communication using Tx and Rx pins. It is an open-source platform, means the boards and software are readily available and anyone can modify and optimize the boards for better functionality. This board comes with all the features required to run the controller and can be directly connected to the computer through USB cable that is used to transfer the code to the controller using IDE (Integrated Development Environment) software, mainly developed to program Arduino. IDE is equally compatible with Windows, MAC or Linux Systems, however, Windows is preferable to use. Programming languages like C and C++ are used in IDE. Apart from USB, battery or AC to DC adopter can also be used to power the board. There are many versions of Uno boards available, however, Arduino Nano V3 and Arduino Uno are the most official versions that come with Atmega328 8-bit AVR Atmel microcontroller where RAM memory is 32kb.

C. Introduction to RFID

A radio frequency identification reader (RFID reader) is a device used to gather information from an RFID tag, which

[a] **Corresponding Author**
Email Addresses: pimpalkhutevarad@gmail.com (Varad Pimpalkhute)

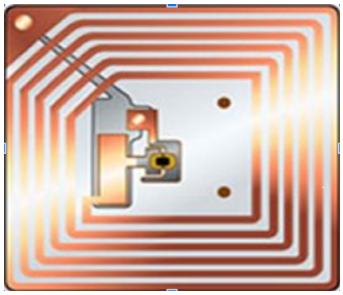

Fig. 1. RFID Tag

Fig. 2. RFID Reader

is used to track individual objects. Radio waves are used to transfer data from the tag to a reader.

RFID is a technology similar in theory to bar codes. However, the RFID tag does not have to be scanned directly, nor does it require line-of-sight to a reader. The RFID tag it must be within the range of an RFID reader, which ranges from 3 to 300 feet, in order to be read. RFID technology allows several items to be quickly scanned and enables fast identification of a particular product, even when it is surrounded by several other items.

RFID tags have not replaced bar codes because of their cost and the need to individually identify every item. RFID technology may be used in a variety of applications including:

- Passports
- Smart cards
- Airplane luggage
- Toll booth passes
- Home appliances
- Merchandise tags
- Animal and pet tags
- Automobile key-and-lock
- Monitoring heart patients
- Pallet tracking for inventory
- Telephone and computer networks
- Operation of spacecraft and satellites

RFID technology uses digital data in an RFID tag, which is made up of integrated circuits containing a tiny antenna for transferring information to an RFID transceiver. The majority of RFID tags contain at least an integrated circuit for modulating and demodulating radio frequency and an antenna for transmitting and receiving signals. Frequency ranges vary from low frequencies of 125 to 134 kHz and 140 to 148.5 kHz, and high frequencies of 850 to 950 MHz and 2.4 to 2.5 GHz. Wavelengths in the 2.4 GHz range are limited because they can be absorbed by water. A Basic RFID System: 3 Main Components of a RFID System are

- A RFID tag: It consists of a silicon microchip attached to a small antenna and mounted on a substrate and encapsulated in different materials like plastic or glass veil and with an adhesive on the back side to be attached to objects.
- A reader: It consists of a scanner with antennas to transmit and receive signals and is responsible for communication with the tag and receives the information from the tag.
- A Processor or a Controller: It can be a host computer with a Microprocessor or a microcontroller which receives the reader input and process the data.

2 Types of RFID Systems:

- Active RFID system: These are systems where the tag has its own power source like any external power supply unit or a battery. The only constraint being the life time of the power devices. These systems can be used for larger distances and to track high value goods like vehicles.
- Passive RFID system: These are systems where the tag gets power through the transfer of power from a reader antenna to the tag antenna. They are used for short range transmission.

Here we are mostly concerned with the passive RFID system as it is most widely used in regular applications like in retail market organizations. A brief idea about How the Passive RFID System Works: The tag can be powered either using inducting coupling method or through EM wave capture method. Lets us have a brief knowledge about the system using these two methods.

- A Passive RFID system using Induction coupling method: In this approach the RFID tag gets power from the reader through inductive coupling method. The reader consists of a coil connected to an AC supply such that a magnetic field is formed around it. The tag coil is placed in the vicinity of the reader coil and an electromotive force is induced it by the virtue of Faraday's law of induction. The EMF causes a flow of current in the coil, thus producing a magnetic field around it. By the virtue of Lenz law, the magnetic field of the tag coil opposes the reader's magnetic field and there will be a subsequent increase in the current through the reader coil. The reader intercepts this as the load information. This system is suitable for very short distance communication. The AC voltage appearing across the tag coil is converted to DC using rectifier and filter arrangement.
- A Passive RFID system using EM wave propagation method: The antenna present in the reader transmits electromagnetic waves which are received by the antenna

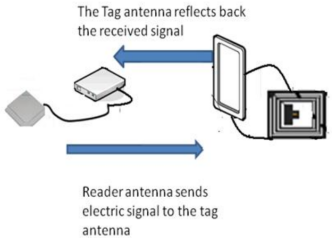

Fig. 3. Passive RFID using EM wave transmission

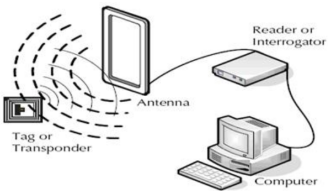

Fig. 4. Active RFID System

present in the tag as potential difference across the dipole. This voltage is rectified and filtered to get the DC power. The receiver antenna is kept at different impedance which causes it to reflect a part of the received signal. This reflected signal is received by the reader and monitored accordingly.

How the Active RFID System Works: In the active RFID system, the reader sends signal to the tag using an antenna. The tag receives this information and resends this information along with the information in its memory. The reader receives this signal and transmits to the processor for further processing.

II. Literature Review

Dr. Suryaprasad J[1] in "A Novel Low-Cost Intelligent Shopping Cart" proposed to develop a low-cost intelligent searching aid that assists the client to go looking and select product and inform the client on any special deals out there on the product as they move around within the shopping complex.

Amine Karmouche [2] in "Aisle-level Scanning for Pervasive. RFID-based Shopping Applications" proposed to develop a system that's ready to scan dynamic and static products in the shopping space using RFID Reader antennas. Instead of conducting the RFID observations at the level of individual carts, aisle-level scanning is performed.

Satish Kamble [3] in "Developing a Multitasking Shopping. Trolley Based on RFID Technology" proposed to develop a product to help someone in everyday searching in terms of reduced time spent while purchasing. The main aim of proposed system is to produce a technology oriented, low cost, easily scalable, and rugged system for assisting shopping in person.

Mr. P. Chandrasekar [4] in "Smart Shopping Cart with Automatic billing System through RFID and ZigBee" proposed to develop a cart with a Product Identification Device (PID) which will contain a microcontroller, a LCD, an RFID reader, EEPROM, and ZigBee module. Purchasing product information will be read through a RFID scanner on cart, meanwhile product information will be stored into EEPROM attached to it and this EEPROM information will be send to Central billing System through ZigBee module. The central billing system gets the cart data and EEPROM information, it access the product database and calculates the total amount of purchasing for that particular cart.

III. Materials and Method

In this section, we will be discussing the materials used for building the unit as well as the method and intricacies involved while performing the experiment.As the main part of designing this shopping cart is to make tag/id detection an internal part of the cart. As far as the prototype is concerned, this project makes use of an RFID card/tag reader.

IV. List of Components

A. RFID reader

B. RFID tags

C. Tap switches(2)

D. connecting wires

E. Arduino uno

F. ESP 8266 module

V. What the shopping cart is capable of?

- Sense the items based on their tags.
- Permit the removal of any unwanted items at the time of payment
- Connect to local server and display the list of items added into it
- Generate a customer id

VI. Working

We often go out for shopping in different shopping malls. The mostly face problem in case of shopping is the waiting time at the billing desk. This project provides a solution to this problem and make it convenient for any person to do shopping at any shopping mall. For the prototype purpose we are using RFID id reader to scan the products which are available in any shopping mall. Whenever a person enters the shopping mall and takes the cart for shopping an id will be generated for that person. That id will be synchronized with the cart and the individual's shopping bill will be generated under that id name. Once the person finishes his shopping then he/she can use the same id to pay the bill either online/offline. As the id is synced with the bill it is easy to get the list of items purchased just by referencing to id. All that an individual need to do is entering the generated customer id in specified website to synchronize the trolley with id and make the billing under that id.

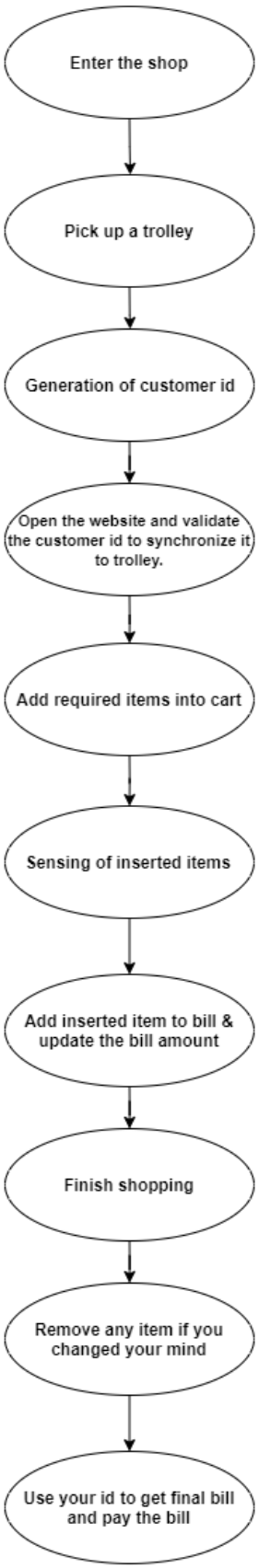

Fig. 5. Flow chart of working

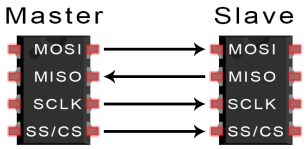

Fig. 6. Active RFID System

Fig. 7. SPI Data Transmission

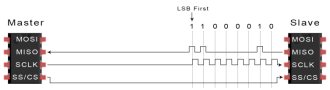

Fig. 10. Slave to master data transfer

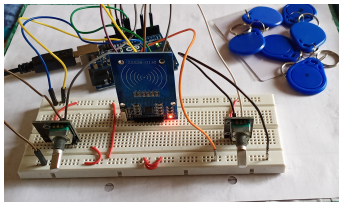

Fig. 11. Prototype of the proposed model

A. Serial Peripheral Interface

Devices communicating via SPI are in a master-slave relationship. The master is the controlling device (usually a microcontroller), while the slave (usually a sensor, display, or memory chip) takes instruction from the master. The simplest configuration of SPI is a single master, single slave system, but one master can control more than one slave (more on this below).

MOSI (Master Output/Slave Input) – Line for the master to send data to the slave.

MISO (Master Input/Slave Output) – Line for the slave to send data to the master.

SCLK (Clock) – Line for the clock signal.

SS/CS (Slave Select/Chip Select) – Line for the master to select which slave to send data to.

STEPS OF SPI DATA TRANSMISSION 1. The master outputs the clock signal:

2. The master switches the SS/CS pin to a low voltage state, which activates the slave:

3. The master sends the data one bit at a time to the slave along the MOSI line. The slave reads the bits as they are received:

4. If a response is needed, the slave returns data one bit at a time to the master along the MISO line. The master reads the bits as they are received:

The clock signal synchronizes the output of data bits from the master to the sampling of bits by the slave. One bit of data is transferred in each clock cycle, so the speed of data transfer is determined by the frequency of the clock signal.

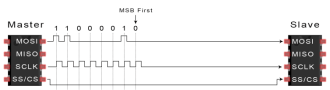

Fig. 8. Master to slave Data Transfer

Fig. 9. Slave select Activation

SPI communication is always initiated by the master since the master configures and generates the clock signal.

VII. Security point of view:

To make sure of proper purchase made by any individual the idea is to design the cart in such a way that individual is allowed to put the items whatever he/she wants into the cart but cannot remove items until he finishes the shopping . An option will be given to person after finishing the shopping to choose those items from the list which he want to remove. The billing amount will update accordingly and then he/she can do the payment by leaving the unwanted items.

VIII. Program Code

Refer to the following link for the program code https://github.com/bvvaibhav7/Automatic-Shopping-system-using-smart-trolley

IX. Prototype of proposed system

X. Results and Discussion

The RFID module MRFC522 is using Serial Peripheral Interface (SPI) communication to communicate with the arduino micro controller ATMEGA328.The advantage of serial communication over parallel communication is also understood. Incase of serial communication only after the previous bit is receved , the next bit is received. This assures the loss less data transfer when compared to the parallel communication.

XI. Conclusion

Though the project is very unique in terms of ideology there are certain limitations in it. One issue is the misuse of the scanner. It purely depends on the case of considering that the shopper is humble and truthful while shopping. So that's why there arises a case of making the cart more secured in terms of giving permission for removal of items during the shopping time.

XII. Future Work

As concerned to prototype the display of bill is not made available for an individual on website so as to make it convenient for him to check the list of items quite often. But this improvement can be made possible.
Also this project can be generalised for any shopping place by storing the information of the items on server and fetching that information whenever the rfid tag is read. So instead of programming the list of items, and displaying the list through the program coding, the main task of the reader installed in trolley can be minimized to just read the id of tag scanned and send it to server so that the server can fetch the details and display the bill accordingly.

To make the shopping more secured from the shop owners point of view the cart can be designed in such a way that it opens whenever a tag is scanned and then closes back and then will open only after the final billing is done. At the time of final billing the cart can be supervised by the shop workers to make sure that customer leave out the items for which he/she opted out of purchasing.

Acknowledgment

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