A Project entitled

"IOT BASED SMART TROLLY WITH AUTOMATIC BILLING SYSTEM"

Completed at

Government College of Engineering, Karad
(An Autonomous Institute of Govt. of Maharashtra)
for the degree of

BACHELOR OF TECHNOLOGY

in
ELECTRONICS AND TELECOMMUNICATION ENGINEERING

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Government College of Engineering, Karad

2022-2023

Declaration by the Student

I hereby declare that the thesis entitled **"IOT BASED SMART TROLLEY WITH AUTOMATIC BILLING SYSTEM"** completed and written by me has not formed earlier the basis for the award of any degree or similar title of this or any other University or examining body.

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This is to certify that following students have successfully completed the project entitled **"IOT BASED SMART TROLLEY WITH AUTOMATIC BILLING SYSTEM** "for the award of the Degree of Bachelor of Technology in Electronics and Telecommunication Engineering in VIIIth semester of academic year 2022-23

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Acknowledgement

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Abstract

In metro cities we can see you a huge rush at shopping malls on holidays and weekends. This becomes even more when there are huge offers and discounts.

In such situations, when you want to buy only a handful of stuff, it becomes very annoying to look through the entire store to find them. We eventually ask the people employed by the store to help us but that too is bit time consuming since the stores now a days are really huge and big. Now a days people purchase a variety of items and put them in the trolley. After total purchasing one should approach counter for billing purpose. By using barcode reader, the cashier prepares the bill which is a time-consuming process. This results in long queues at the billing counters.

This project presents an idea to develop a system in shopping malls to overcome the above problems. To achieve this all products in the mall should be equipped with RFID tags and all trolleys should be equipped with a Device which we have made to accelerate the whole process of shopping. Further there is an android application that we have made as a part of this project. After entering the store, we just need to connect the android application to the device fitted on the trolley using the Bluetooth and simply start moving through the aisle. Whenever a product we wish to buy which, we earlier added to the cart of our android application is present one of the sections across the aisle, the device will notify us regarding this. When one puts any product in the trolley its code will be detected automatically, the item name and cost will be displayed on the application, thereby the cost gets added to the total bill. If we wish to remove the product from the trolley, you can take away the product and the amount of that specific product gets deducted from total amount and the same information passes to the application via Bluetooth module. Hence the billing can be done in the trolley itself thereby saving a lot of time to the customers.

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List of Abravations

IOT: Internet of Thing
GUI: Graphical User Interface

RFID: Radio frequency Identification device

AI: Artificial Intelligence

POS: Payment operating System

API: Application Programming Interface

SQL; Structure Query Language

HTML: Hypertext Markup Language

CSS: Cascading Styling Sheet

JS: JavaScript

PHP: Hypertext Preprocessor

CSV: Current Shopping Environment

LCD: Liquid Crystal Display

DC: Direct Current

NLP: Natural Language Processing

ML: Machine Learning

PO: Payment Option

UI: User Interface

DNS: Domain Name System

SSL: Secure Socket Layer

AL: Application Layer

MAC: Media Access Control

CDN: Content Delivery Network

PAN: Personal Area Network

WAN: Wireless Area Network

WC: Wireless Connectivity

List of Publication

1. Kalpesh Gaikwad, Tejas Patil, Shubham Patil and Shreyash Thorat, “Revolutionizing the Shopping Experience: An IoT-Based Automated Billing System for Smart Trolleys,” The International Conference on 6G and Wireless Network Technology|3-4 April-2023

CHAPTER 1 INTRODUCTION

Individuals have constantly created innovation to bolster their requirements as from the start of humankind. The fundamental reason for development in innovation is ought for more independency and this leads to improving tasks and making regular one simpler and speedier. One significant task that individuals invest maximum measure of energy is in shopping. Shopping center is a spot where individuals get their everyday necessities running from sustenance items, garments, electrical machines and so forth. Some of the time clients have issues with respect to the unspecific data about the item marked down and misuse of superfluous time at the counters. In this innovative world, each grocery store and supermarkets utilize shopping trolleys with a specific end goal to help clients to choose and store the items which they expect to buy. Customers usually purchase the products required and place them in their carts and thereafter wait at the counters for payments of bills. The payment of bills at the counters is really troublesome and time-consuming process which thereby increasing a heavy crowd at the counters.

Figure 1.1 Current Shopping Environment

A smart trolley with automatic billing system is a revolutionary solution that aims to streamline the shopping experience for customers and retailers. It is an advanced system that integrates various technologies to provide a seamless and efficient shopping experience for customers. The smart trolley is equipped with various sensors, RFID scanners, and cameras that track the items placed in the trolley. The system automatically identifies the items and calculates the total cost of the items. This eliminates the need for manual scanning of items and speeds up the checkout process.

The automatic billing system also enables customers to make payments directly from the trolley, eliminating the need to queue at the checkout counter. This saves time and provides a more convenient shopping experience for customers. In addition, the smart trolley also has various features to enhance the shopping experience for customers. It can display product information, provide recommendations, and even offer personalized discounts based on the customer's purchase history. For retailers, the smart trolley provides a wealth of data on customer behavior and shopping patterns. This information can be used to optimize store layout, product placement, and marketing strategies to improve sales and customer satisfaction.

Overall, the smart trolley with automatic billing system is a game-changer in the retail industry, offering an advanced solution that improves the shopping experience for customers and retailers alike. By leveraging cutting-edge technologies, it streamlines the shopping process, saves time, and provides a more convenient and personalized experience for customers.

1.2. Problem Statement

This project's challenges are inclusive of elimination of accidents caused by shopping trolleys operated by humans. Human error in this matter, as we all know, causes minor collisions frequently bumping to toes and feet as well as racks and shelves in the mall. Meanwhile, the carelessness of human may contribute to more serious accidents involving trolleys with loaded goods, children and other shoppers. We are hopeful to eradicate these accidents using our proposed solution.

1.3. The Relevancy of the Project

Relevancy of the project includes structured programming. The language which governs the system will be in Python language. Aside from structured programming, electrical machines will be incorporated because there will be need of calculating torques for motor usage for the trolley drive wheels.

1.4. Objective and Scope of Study

The objective of this project is to design and develop a prototype of an automated motorized shopping cart, capable of trailing shoppers along with the extensive ability to avoid obstacles with its built-in intelligence. The scope of study for this project is to study and apply the suitable method for human tracking, obstacles avoid and interface the whole system with microcontroller

1.5. Project outline:

The main aim of the project is to satisfy the customer and to reduce the time spent on the billing process which is to complete the billing process in the trolley rather than waiting in a queue even for one or two products. The customers must add the products after a short scan in trolley and when the shopping is done the finalized amount will be displayed in the trolley. Customer could either pay their bill by their pre-recharged customer card provided by the shop. Finally, the whole information will be sent to central Pc of the shopping mall.

1.6. Significance:

A smart trolley, also known as a smart cart or intelligent cart, is a shopping cart that uses technology to enhance the shopping experience for customers and retailers. Here are some of the significant benefits of using smart trolleys:

1: Increased Efficiency

2: Reduced Queues

3: Personalized Recommendations

4: Real-time Inventory Management

5: Improved Customer Experience

CHAPTER 2 LITREATURE SURVERY

As per our knowledge only few papers were found in the literature for the automated shopping trolley for supermarket using RFID. The automated shopping trolley for supermarket billing system implemented by **Sainath (2014)**, exploited barcode for billing of products, where customer scans the product using barcode technology. The bill will be forwarded to the central billing system where customer will pay them by showing unique id. The limitation of barcode scanning requires line of sight for scanning and it should be fixed within its boundary. Cash register lines optimization system using RFID technology by **Budic (2014)**, developed a system for shopping using RFID. The RFID is employed for scanning products and the information is stored in the database which could be paid online or in a central bill. It also uses web application to maintain entire shopping details. It requires maintenance of web application server. No necessary steps have been taken for the products that are accidentally dropped into the trolley by the customer. IOT based intelligent trolley for shopping mall by **Dhavale Shraddha (2016)**, applied RFID technology for billing during purchase in shopping malls and IOT is used for bill management by means of ESP module. The payment details will be sent to the server by which central billing unit will deal with customer's payment. The ESP module will be working as a short distance Wi-Fi chip for wireless communication. But there is a drawback which includes constraints such as distance and interference. Server will be busy if customers are high and internet connectivity should be stable for finishing the process. Smart shopping trolley using RFID by **Komal Ambekar (2015)**, implemented smart way of shopping trolley with RFID and ZigBee by which bill is generated by scan of products in the reader and bill transmitted to central billing department by which bill can be paid at the counter which is a major difficulty for the customer. Smart shopping cart with customer-oriented service by **Hsin-Han Chiang (2016)**, accomplished a concept of automated shopping trolley with automated billing where they used face recognition for customer authentication. It is not a simple process as face recognition of customers during shopping hours will not be easy and accurate as malls can be crowded. Many errors are possible while using recognition for authentication. Smart RFID based Interactive Kiosk Cart using wireless sensor node by **Narayana Swamy (2016)**, applied RFID for automated shopping. They used dedicated website for billing maintenance and for user interaction. Every user with the unique id accesses the webserver for the bill payment and invoice information. Internet service is mandatory in this type of service. So, the process may fail due to internet instability and server error problems may also occur due to high load. Shopping and automatic billing using RFID technology by **Vinutha (2014)**, has an automatic billing with server end. This scans products by radio frequency identification and then the bill is generated at the server end which is then communicated to the customer. This requires server maintenance and internet connectivity both for the customer and shopkeeper. Smart shopping cart with automatic billing and Bluetooth proposed by **Prateek Aryan (2014)**, is a process where billing is done in a trolley and transferred to the android mobile of the user via Bluetooth. Every customer can't be expected to have a smart phone and Bluetooth can have connectivity issues and range is less. Automated smart trolley with smart billing using Arduino by **Suganya (2016)**, developed a model of automatic shopping with Arduino and an android application which again requires network to be connected always. Android operated mobiles may or may not be present with every customer. Network instability leads to delay in the billing. RFID enabled smart billing system by **Vanitha Sheeba and Brindha Rajkumari (2015)**, did a concept model consists of RFID and ZigBee which transmits generated bill to the server and

then the bill is collected by the worker in the bill counter by identifying customers. But this again will lead to queue for billing since only bill generation is alone automated by scanning using RFID. Our idea has a stable and simple billing process of making payment in the trolley itself. Since it avoids the requirement of Wi-Fi, ZigBee, ESP module and others which is used above. It can be paid using customer card or the ATM card. Above concepts doesn't ensure security and theft of products either intentionally or accidentally. We used door by which products cannot be dropped without scanning by the customer. We also have used separate IR sensor to avoid the accidental dropping of products. To make it more effective we used code logic which correlates the IR count and RF count in the microcontroller. For security we installed password authentication feature by which each customer possesses unique card with unique password. Barcode technology is replaced by RFID in our system which gives fast and accurate scanning of products.

Paper I: M. Kumar, P. Varma "IoT-Based Smart Shopping Cart Using Radio Frequency Identification"

The modern age of technology in which most of the customer needs to wait in the supermarket for shopping because it is a highly time-consuming process. A huge crowd in the supermarket at the time of discount offers or weekends makes trouble to wait in long queues because of a barcode-based billing process. In this regard, the Internet of Things (IoT) based Smart Shopping Cart is proposed which consists of Radio Frequency Identification (RFID) sensors, Arduino microcontroller, Bluetooth module, and Mobile application. RFID sensors depend on wireless communication. One part is the RFID tag attached to each product and the other is RFID reader that reads the product information efficiently. After this, each product information shows in the Mobile application. The customer easily manages the shopping list in Mobile application according to preferences. Then shopping information sends to the server wirelessly and automatically generates billing. This experimental prototype is designed to eliminate time-consuming shopping process and quality of services issues. The proposed system can easily be implemented and tested at a commercial scale under the real scenario in the future. That is why the proposed model is more competitive as compared to others.

In the aforementioned paper, the intended system design 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 operating 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 by using different proposed methods 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

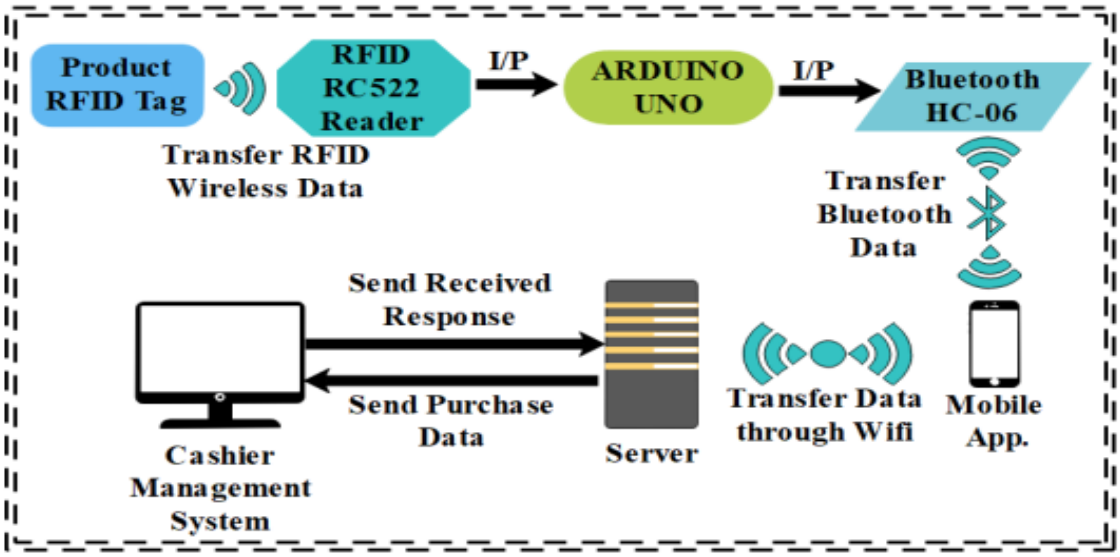

Fig 2.1 Workflow of Paper I

Paper II: Hanooja T, Raji C.G, Sreelekha M "Human Friendly Smart Trolley with Automatic Billing System".

Shopping and buying are an integral part of our daily lives. Big mega markets have a wide variety of items and different stores can have different deliveries of goods. It is difficult for many consumers to stand in the long queue for the billing of goods purchased. This causes a wastage of money and a poor bill for the wrong customer. Trolleys are used in supermarkets or grocery stores to make shopping simpler. However, it is difficult for customers to control the trolley while shopping. An automated customer following trolley was implemented which calculates the total sum of grocery items carried in the trolley by the customers. This reduces the customer's effort to pull the trolley and keep the line for the payment of the grocery products. The customer who has a specific tag and a web camera installed in front of the trolley will recognize the tag and move the trolley to the customer. Using the RFID tag and the Raspberry Pi receiver, the item bill inserted has been obtained in the trolley. This results in an ideal solution to all these problems.

Human Friendly Smart Trolley with Automated Billing System is a system that follows the customer and gives the bill of the product that is inserted in it. It will be much easier for aged customers and children to use trolleys without any effort. By using the product, we can save time for the customer especially in the billing part. The proposed system is a unique solution by utilizing the low-cost electronic components and the structural design can be implement on existing trolley. As the proposed design is less complicated, existing normal trolley can be converted to smart trolley with lesser investments. It is sure that the system is very much helpful for the customers and without bothering about their trolley; they can make their purchase easy. Trolley and the customer will be provided with the same color tag and the matching enables the customers to use their trolley easily. Carrying trolley along with the customers is a very difficult task for the customers. The proposed system provides an easy way to reduce all these problems. In future, we hope that we can provide a system, which is more user friendly.

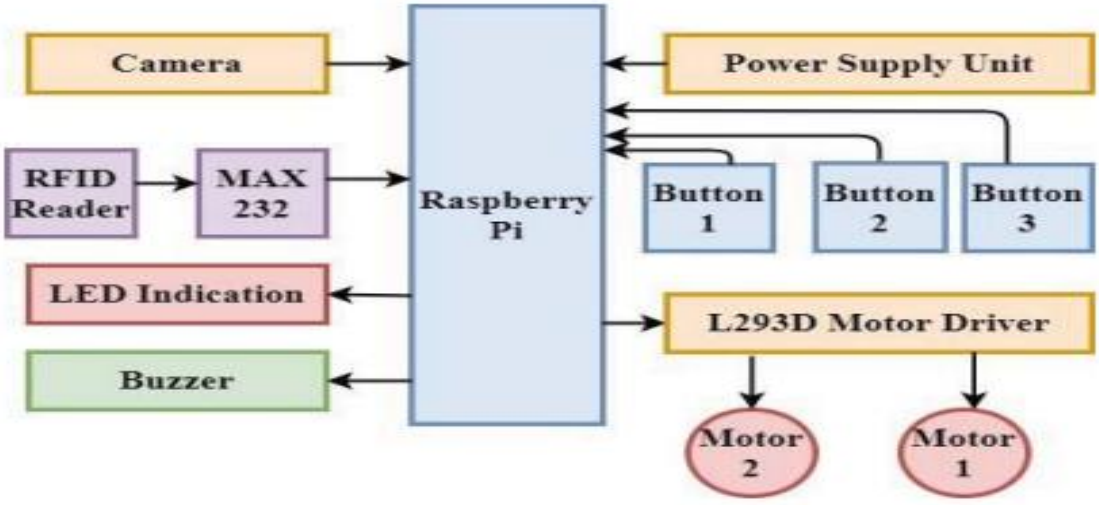

Fig 2.2 Block Diagram of Paper II

Paper III: Aileen Anak Bita, Safaa Najah Saud Al-Humairi Towards "A Sustainable Development Cities Through Smart Shopping Trolly: A Response to the Covid-19 Pandemic"

The use of trolleys in the shopping industry has always been very popular, especially among customers who frequently stop by the mall or supermarket to shop for their necessities. People need trolleys to make it easier for them to carry their groceries and other luggage. There are various types of trolleys according to their respective uses. Still, the trolleys in the shopping industry commonly used today can only help users carry goods from one place to another. However, this traditional type of trolley is still lacking in being a perfect fit in the shopping industry. It does not help reduce the crowds and the enormous queue in terms of inconvenience. Therefore, this project aims to design a smart trolley equipped with an Arduino NANO, RFID, and a barcode scanner. It can also be synchronized with the mobile application via a WIFI module. This new technology will replace the traditional one, which will help consumers maintain social distancing during the age of the COVID-19 pandemic.

After months of analysis, development, and implementation, this final year project has been completed. The objectives have been achieved as well. A Smart shopping trolley prototype model has been designed whereby an Arduino NANO, RFID, and a product code scanner are attached. It can be synchronized with the mobile application via a WIFI module. Hence, this project offers a Smart circuit on the shopping trolley for use within the shopping industry. To elaborate, this new system will take the consumer's experiences to a whole new level. Whenever they go shopping, they will use a trolley to help them scan and calculate the total cost of the items they have picked up, thus avoiding the long queues, providing contactless payment through a smartphone application, and making life easier the cashier. It can be concluded that such development of the Smart shopping trolley will present an option that is more competent, more enjoyable to use, and more user-friendly as no special skills are required to use the trolley. We hope that this innovation looking to replace the traditional trolley will become more prominent with the Smart shopping trolley in our country.

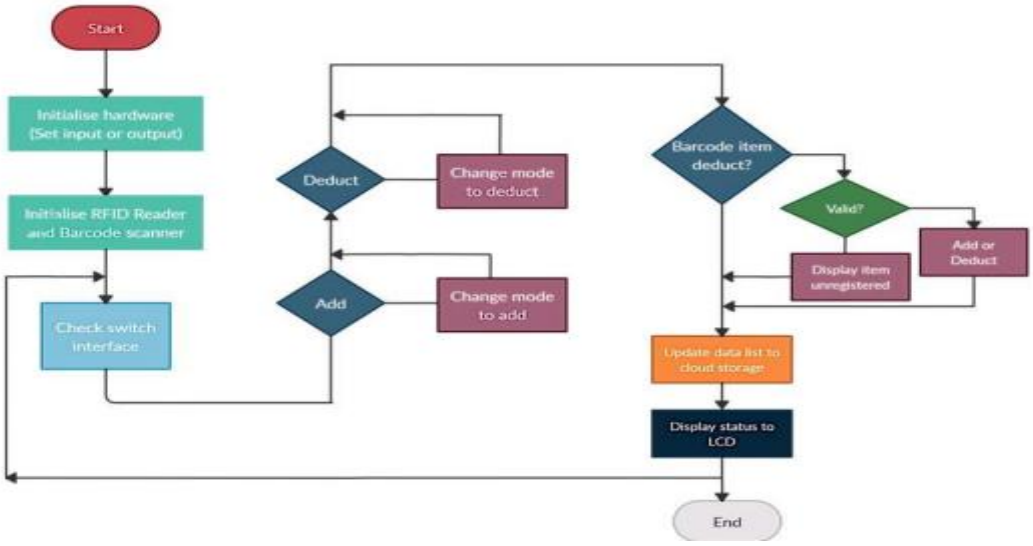

Fig 2.3 Workflow of Paper III

Table 1: Comparison between Programmable Logic Controller (PLC) and microcontroller (μC)

	Programmable Logic Controller (PLC)	**Microcontroller (μC)**
Power supply	Most work with 24VDC or 230VAC	Most work with 5VDC
Programming language	Ladder diagrams, Statement list	Assembly, C, C++, Basic
Application	Designed for industrial purposes	Designed for used in consumer electronic system
Current driving capacity	Large	Small
Size	Large	Small
Cost	High	Low

Table No: 2.1

Paper IV: Tapan Kumar Das, Member, IEEE, Asis Kumar Tripathy, Member, IEEE and Kathiravan Srinivasan "A Smart Trolley for Smart Shopping".

Shopping is really fascinating and alluring; at the same time, it involves getting tired due to standing in a long queue for the bill and payment process. Hence, it is proposed to design a smart trolley which can take care of shopping and billing. By this, the customer can walk straightaway into the shop, purchase products using the smart trolley and walk out of the shop. He gets the e-bill through the mail, and he can view his purchase details using the shop's website. In order to realize this, we need an Arduino board, Radio-Frequency Identification (RFID) reader, RFID tag, LCD display, ESP8266 Wi-Fi module, database manager and a website to maintain product and customer details, which can be accessed by the admin anywhere in the world. This is an IOT based system where the trolley can interact with the network spread worldwide.

Each product in the shop has an RFID tag and each trolley is equipped with a RFID reader. Payment is made by the customer card. The smart trolley system is very efficient for both customers as well as the shop owners. This system is robust and consistent since it can work both online and offline. People always wanted to buy new stuffs to satisfy their needs; however, some people hate it mainly because of the crowd, long queues in the shop, billing, etc. In a big shopping mall, it is very difficult to search for a particular product. In light of these, the smart trolley seems to be a better alternative for all these woos. In future, this system can be improved further by providing face recognition instead of smart cards. By this, all details are stored online with the customer's face as identity. This makes the customer come to the shop and take a trolley and do all purchasing and can walk out of the door. There is no need of customer's smart card. The bill will be sent to his mail id, and money can be deducted directly from the customer's bank account. However, smart trolley can be improved in security aspect also by providing consumers privacy and it must guarantee secure online transaction.

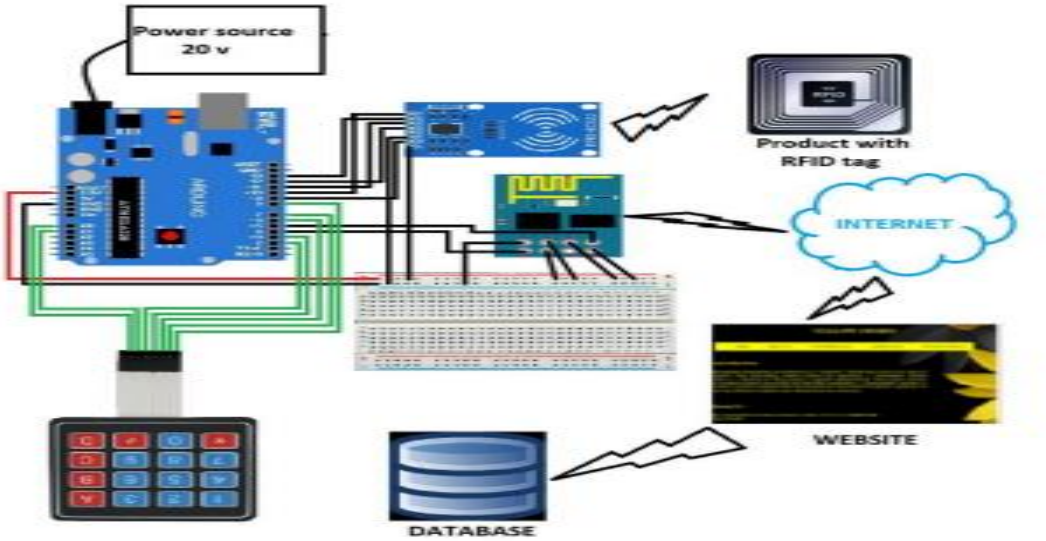

Fig 2.4 Circuit Diagram of Paper IV

Paper V: Kowshika S, Mahalakshmi B "IoT based Smart Shopping Trolley with Mobile Cart Application"

Even through e-commence and other online applications are growing rapidly the craze for traditional shopping has never stepped back. One difficulty is to follow up in a queue for the billing process. There, arises a demand for easy and quick payment of bills. The proposed Smart Cart in this paper, is capable of generating bill using IoT along with the mobile cart application. With the use of this mobile application and trolley, customer can make bill payment in no time. The smart cart uses the RFID tag and receiver to scan the product, load cell to prevent theft, LCD display and the Raspberry pi Along with this the customer can also log in with the mobile app which will display the list of all the products mentioned and their amount. Once done, the customer can pay the bill through the mobile application

In, this paper we have successfully demonstrated the system of RFID that would be the best replacement of the traditional barcode scanner. There is m any drawbacks in the barcode scanning process like the scanner must be placed in certain distance and inability to update information. Finally, there is an end to the long queues. successful use of RFID and loadcell system of smart shopping trolley with cart mobile application has been demonstrated. The drawbacks addressed in previous applications such as theft prevention, data storage, has been overcome in this application. Though, the man power is required but it attracts m any customers because of various available options particularly mean t for the corresponding shop

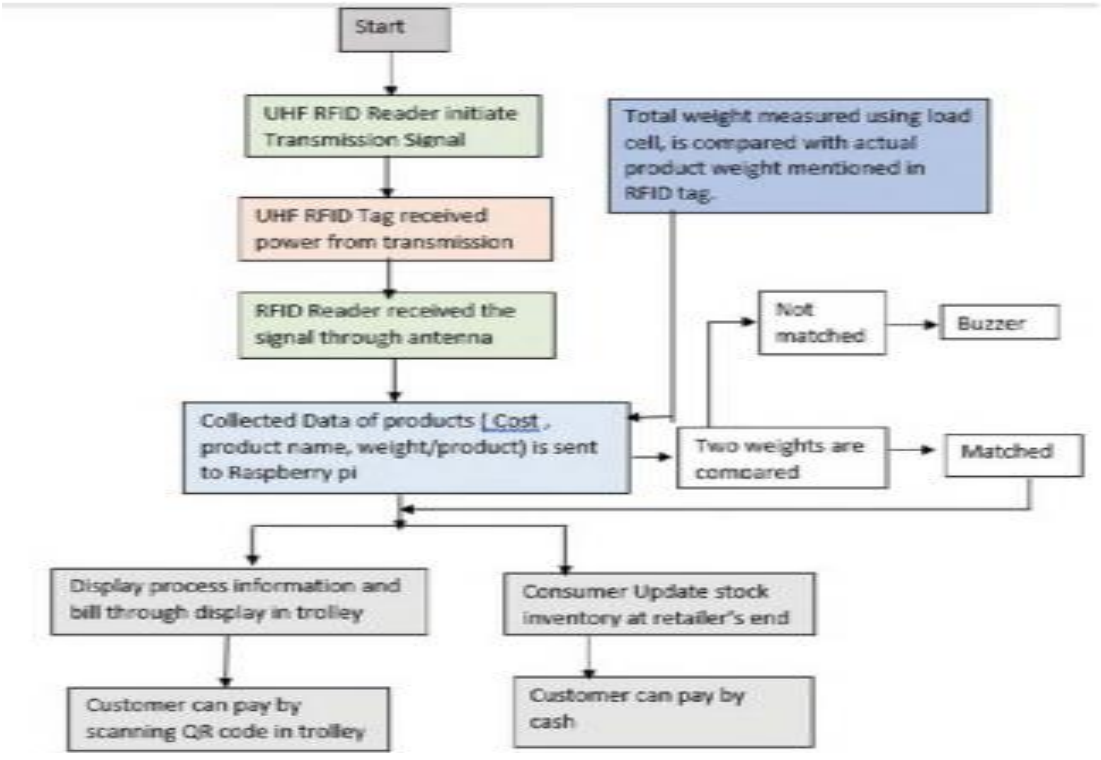

Fig 2.5 Workflow of Paper V

CHAPTER 3 SYSTEM OVERVIEW

Purpose of Project:

The fundamental motivation behind this system is to show the proposition of a design and arrangement of an inventive framework for obtaining of items in markets. This cart explores rising versatile innovations and programmed recognizable proof advancements, (for example, RFID) as an approach to enhance the nature of administrations given by retailers and to expand the customer esteem consequently permitting to save time and cash. With this device an excellent opportunity will be developed which assists the customers by showing the catalog of products and their respective costs. This approach thereby helps the inventory management unit with an instinctive upgrade on each purchase of product. This smart cart has the capability to make shopping more relaxable, comfortable and systematic for the customers as well as making easier for the store management. Further the doesn't require the extra staff to handle the customers, so profit margins can be increased for store owners.

Hardware Specification:

3.1: RFID (Radio Frequency Identification**)**

RFID or Radio Frequency Identification system consists of two main components, a transponder/tag attached to an object to be identified, and a Transceiver also known as interrogator/Reader.

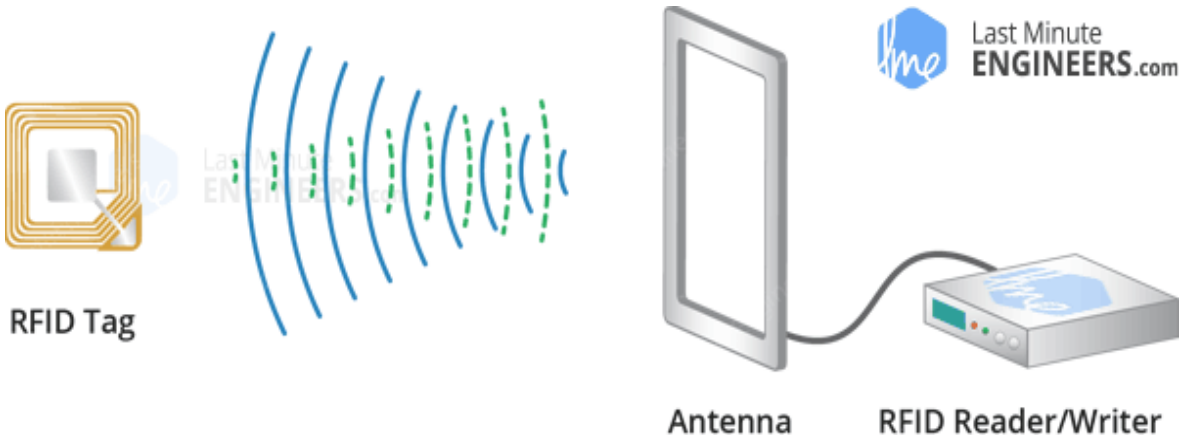

Fig 3.1 Architecture of RFID

A Reader consists of a Radio Frequency module and an antenna which generates high frequency electromagnetic field. On the other hand, the tag is usually a passive device, meaning it doesn't contain a battery. Instead, it contains a microchip that stores and processes information, and an antenna to receive and transmit a signal.

To read the information encoded on a tag, it is placed in close proximity to the Reader (does not need to be within direct line-of-sight of the reader). A Reader generates an electromagnetic

field which causes electrons to move through the tag's antenna and subsequently power the chip.

The powered chip inside the tag then responds by sending its stored information back to the reader in the form of another radio signal. This is called backscatter. The backscatter, or change in the electromagnetic/RF wave, is detected and interpreted by the reader which then sends the data out to a computer or microcontroller.

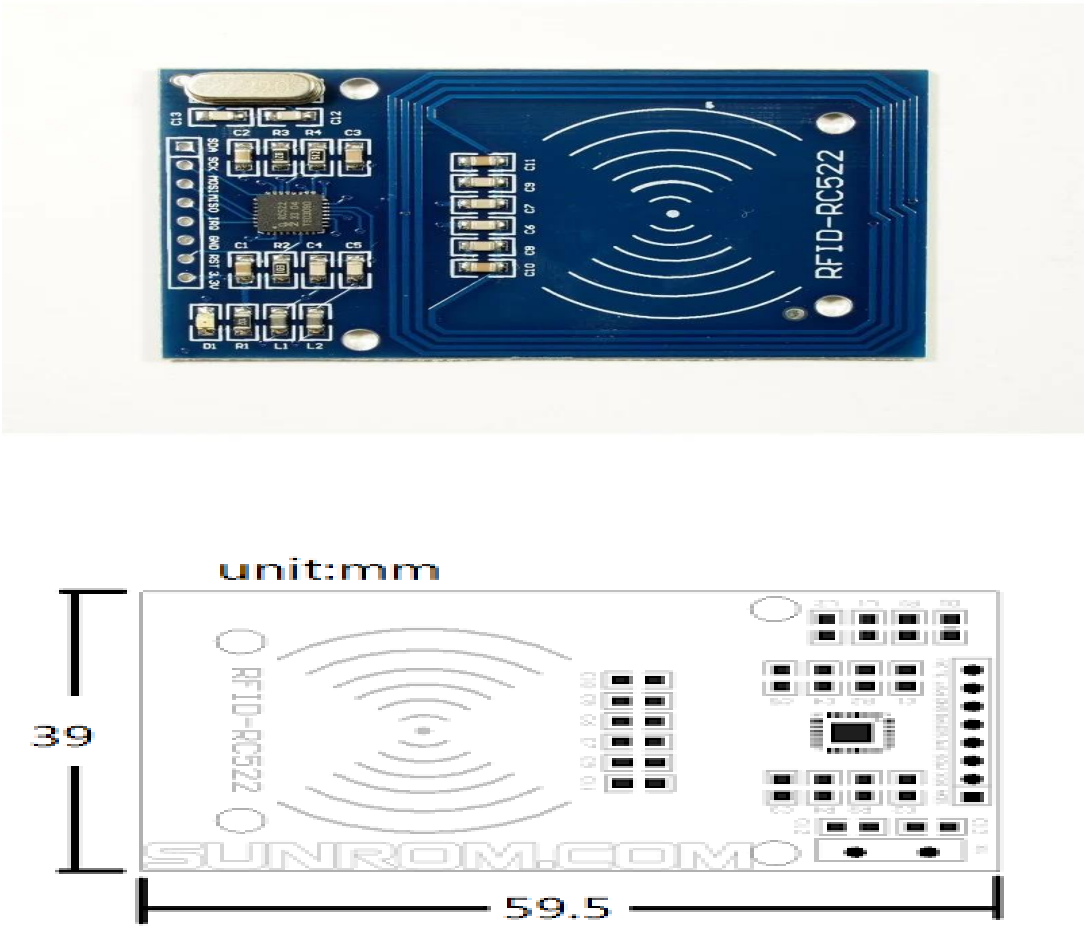

Fig 3.2 Internal Structure of RFID

3.1.1: BARCODE HISTORY

The barcode has been introduced in the year 1932 a small group of students from Harvard University, London first developed the concept of Automatic Product identification by passing a high intensity light through Morse code. Which gradually developed to Bar-coding system from the year,1948 soon the bar-coding technology opened for public use from 1967.

In 1967, the first the first bar coding was introduced to the retail world on a packet of Wrigley's Gum. Thirty-eight years later the number of applications bar code technology has exploded, going far beyond.

RFID advantages over barcodes.

1.No line of sight required for reading

2.Multiple items can be read with a single scan

3.Each tag can carry a lot of data (read/write)

4.Individual items identified and not just the category.

5.Passive tags have a virtually unlimited lifetime.

3.1.2: RFID IMPLIMENTATION

The RFID chip has come a long way since its invention, see the journey below:

1940's - Radar technology was used to identify enemy and friendly aircrafts in WWII. Technically this was the first use of RFID

1948 - Scientist and inventor Harry Stockman creates RFID and is credited with the invention.

1963 - Inventor RF Harrington formulates new RFID ideas which include scattering data and information.

1977 - The first RFID transmitting license plate is created.

2000 - By this time over 1000 patents have been submitted using the RFID technology.

Experts believe that Rfid will be ubiquitous in 20 years, this may be hard to believe if you are not one of the businesses on the cutting edge of RFID technology but may have adopted this technology to reduce the cost and streamline operation.

Radio frequency identification (RFID) is a general term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly, using radio waves.

RFID technologies are grouped under the more generic Automatic Identification (Auto ID) technologies.

The barcode labels that triggered a revolution in identification systems long time ago, are inadequate in an increasing number of cases. They are cheap but the stumbling block is their low storage capacity and the fact that they cannot be reprogrammed.

A feasible solution was putting the data on silicon chips. The ideal situation is contactless transfer of data between the data carrying device and its reader. The power required to operate the electronic data carrying device would also be transferred from the reader using contactless technology.

These procedures give RFID its name.

One grand commercial vision for RFID is to change the way demand-supply chain moves. In the current almost stone-age scenario, manufacturer produces goods based on forecasts and hopes all of them will be consumed before the shelf life gets them. Good, if the market is consistent. Horrible, if a sudden surge makes the supply fall short and hence everyone in the chain miss on profits. Disastrous, if demand dies suddenly and losses are passed along the chain.

In a not-so-distant future, RFID enabled stores will monitor the consumption in real time. Shelf will signal the inventory when it needs more stuff and inventory will pull supplies from the manufacturer based on its level of stock. Simple concept, not-so-difficult implementation and revolutionary results in the pipeline. That's RFID, in short.

3.1.3: RFID TECHNOLOGY AND ARCHITECTURE

Before RFID can be understood completely, it is essential to understand how Radio Frequency communication occurs.

RF (Radio Frequency) communication occurs by the transference of data over electromagnetic waves. By generating a specific electromagnetic wave at the source, its effect can be noticed at the receiver far from the source, which then identifies it and thus the information.

In an RFID system, the RFID tag which contains the tagged data of the object generates a signal containing the respective information, which is read by the RFID reader, which then may pass this information to a processor for processing the obtained information for that application.

Thus, an RFID System can be visualized as the sum of the following three components:

1. RFID tag or transponder

2. RFID reader or transceiver

3. Data processing subsystem

An RFID tag is composed of an antenna, a wireless transducer and an encapsulating material. These tags can be either active or passive. While the active tags have on-chip power, passive tags use the power induced by the magnetic field of the RFID reader. Thus, passive tags are cheaper but with lower range (<10mts) and more sensitive to regulatory and environmental constraints, as compared to active tags.

An RFID reader consists of an antenna, transceiver and decoder, which sends periodic signals to inquire about any tag in vicinity. On receiving any signal from a tag, it passes on that information to the data processor.

3.1.4: RFID STANDARD

Standards are critical in RFID. Be it payment systems or tracking goods in open supply chains. A great deal of work has been going on to develop standards for different RFID frequencies and applications.

RFID standards deal with the following: -

- Air Interface Protocol - The way tags and readers communicate
- Data Content - Organizing of data
- Conformance - Tests that products meet the standard
- Applications - How applications are used.

The way the world has gone about developing the standards is a bit complex. There are two major and somewhat conflicting organizations into the business - ISO and Auto-ID Centre (now handled by EPC Global). Without going too much into the conflict, we'll review the standards proposed by both these organizations.

Tags are required to be disposable (manufacturer may not get the tags back from the retailer to reuse it). Hence, the primary mission for any standard developer is to make the tags low cost. It should operate in UHF, as only UHF delivers read range needed for supply chain applications. And since the goods are needed to be tracked as they move across the globe, the standards must be open and globally accepted. There should also be an accompanying network architecture, which would enable anyone to look up information associated with a serial number stored on a tag. The network too needs to be based on open standards.

EPC standards for tags are the class 0 and class 1 tags:

Class 1: a simple, passive, read-only backscatter tag with one-time, field- programmable non-volatile memory.

Class 0: read-only tag that was programmed at the time the microchip was made.

Class 1 and Class 0 have a couple of shortcomings, in addition to the fact that they are not interoperable. One issue is that they are incompatible with ISO standards. The new EPC standard ~V Gen2 is designed to be fast tracked with ISO standards but for some disagreements over the 8-bit Application Family Identifier (AFI).

ISO has developed RFID standards for automatic identification and item management. This standard, known as the ISO 18000 series, covers the air interface protocol for systems likely to be used to track goods in the supply chain. They cover the major frequencies used in RFID systems around the world.

The seven parts are:

- 18000~V1: Generic parameters for air interfaces for globally accepted frequencies
- 18000~V2: Air interface for 135 KHz
- 18000~V3: Air interface for 13.56 MHz
- 18000~V4: Air interface for 2.45 GHz
- 18000~V5: Air interface for 5.8 GHz
- 18000~V6: Air interface for 860 MHz to 930 MHz
- 18000~V7: Air interface at 433.92 MHz

3.1.4: RFID APPLICATION:

There are two main area of applications, defined broadly as proximity (short range) and vicinity (long range).

Long range or vicinity applications can generally be described as track and trace applications, but the technology provides additional functionality and benefits for product authentication.

RFID enables greater automation of data collection process. Most companies spend considerable effort in knowing what's in their warehouse. RFID will help them dig deeper and much more easily, tracking to the detail of even each unit, long after it has left the factory or warehouse.

RFID allows all this data to be transferred securely. Companies use independent suppliers, data from each of them can be carried on tags and uploaded to the Company's central system.

Imagine the control that the Company will have on a product's life cycle. The creation of successes and defeats can be better understood. There have been numerous instances when companies had to recall the entire product due to a fault in a minor component. Imagine the costs involved in recalling a whole car for a mistake in the AC system! RFIDs can make such recalls much more focused.

There would be better data about postproduction performance. A car could have individually tagged components. Data could be collected everywhere, accident sites, repair shops, even the garage. Even inside the factory, tags could enable faster and focused fault tracing.

The Just in Time (JIT) practice followed by many companies, where components are used when they are delivered and delivered just before being needed, can lead to out of stock situations. RFID will eliminate the problem. The eventual aim of RFID in retail and manufacturing ~W eliminate the intermediary. A perfect supply chain would require no distribution center.

\

Products would be delivered directly from the factory to the retail center. Some other areas where passive RFID has been applied in recent past are:

- Person Identification
- Food Production Control
- Vehicle Parking Monitoring
- Toxic Waste Monitoring
- Valuable Objects Insurance Identification
- Asset Management
- Access Control

Short range or proximity applications are typically access control applications. Some main areas are:

- Access control
- Mass transit ticketing

3.1.5: RFID SECURITY

Through RFID in the near future, every single object will be connected to the Internet through a wireless address and unique identifier, was quipped by the global head of life science and consumer product industries at Sun Microsystems Inc.

Certainly, feels impressive, and let me just help your imagination by setting a perfect scenario.

You are sitting at your home watching television on a Sunday afternoon, and you know that your television is connected to the internet. Your couch, table even your dining set is connected to the internet. That is great for the automation!? Now, imagine your shirt, jeans, even your undergarments connected to the internet! It is only a futuristic setup, but the privacy implications of RFID are equivalent in any application of RFID.

The basic privacy concerns associated with an RFID system is the ability of ubiquitous tracking of anybody without consent. And with RFID tags getting smaller and smaller, it is now even possible to hide tags in such a way that the consumer may be unaware of the presence of tags.

For example, the tags may be sewn up within garment, or molded within plastic or rubber. To the extent that researchers have already developed tiny coded beads invisible to human eye that can be embedded in inks to tag currency and other documents, or added to substances like automobile paint, explosives, or other products that law enforcement officers or retailers have a strong interest in tracking. Researchers say that the technology should be ready for commercial use in 3-6 years.

In summary we can note the following ways in which RFIDs can be used to bypass personal privacy:

- By placing RFID tags hidden from eyes and using it for stealth tracking.
- Using the unique identifiers provided by RFID for profiling and identifying consumer pattern and behavior.
- Using hidden readers for stealth tracking and getting personal information.

With all these privacy concerns, there is bound to be some effort to thwart such attempt at privacy and maintain the popularity of RFIDs. Researches at various places have yielded the following methods of avoiding above-mentioned attacks.

- RSA Blocker Tags: These tags are similar in size and appearance to RFID tags, helps in maintaining the privacy of consumer by Spamming any reader that attempts to scan tags without the right authorization, thus confusing the reader to believe that there are many tags in its proximity.
- Kill Switches: Newer RFID tags are being shipped with a Skill Switch, which will allow the RFID tags to be disabled. Thus, a consumer will be given an option of disabling the RFID tag before leaving the store, thus avoiding the possibility of stealth tracking and profiling.

Consider a Couple of Situations:

- You are in a mall buying a lot of things and now you have to wait in the queue for a long time and when your time comes, the person at the counter checks each item for its barcode, scans it and then the

computer processes it slowly. Overall, it's a quiet time-consuming job both for you and the person at the counter.

- You are supposed to make a database of the students in a school or college or employees of any organization, present at any day. Manually checking the id of each person, making a database, updating it is quite a consuming work to do.

So how about considering an alternative, by the virtue of which you can just pick up things from the mall, place your bag on the scanner and just pay the bill and leave. Also, in the educational institutions or Organizations where you can just assign an ID tag to each member, check their attendance on any particular day through the ID tag.

To achieve the above alternatives, the solution or the technology used is RFID.

3.1.6: TYPES OF RFID

Passive Tags – It is the cheaper version using no battery. The Tag uses radio energy transmitting from the reader. So, the Reader must be close to the tag to transfer energy to power the Tag. Since the tags have unique serial number, the reader can recognize them individually.

Active Tags– These have an on-board battery and periodically transmits ID signals to the reader.

Battery Assisted Passive or BAP– These Tags have small battery on board and will be activated in the presence of signals from the reader.

Read only Tags – These have a unique factory assigned serial number used as the key for the data base.

Read/ Write Tags – These can write object specific data give by the system user.

Field programmable Tags– These can write once but read many times. Black tags can be written with an electronic product code by the user.

3.1.7: RFID NEAR FIELD AND FAR FIELD

Near-field RFID Faraday's principle of magnetic induction is the basis of near-field coupling between a reader and tag. A reader passes a large alternating current through a reading coil, resulting in an alternating magnetic field in its locality. If you place a tag that incorporates a smaller coil in this field, an alternating voltage will appear across it. If this voltage is rectified and coupled to a capacitor, a reservoir of charge accumulates, which you can then use to power the tag chip. Tags that use near-field coupling send data back to the reader using load modulation. Because any current drawn from the tag coil will give rise to its own small magnetic field—which will oppose the reader's field—the reader coil can detect this as a small increase in current flowing through it. This current is proportional to the load applied to the tag's coil (hence load modulation). This is the same principle used in power transformers found in most homes today—although usually a transformer's primary and secondary coil are wound closely together to ensure efficient power transfer. However, as the magnetic field extends beyond the primary coil, a secondary coil can still acquire some of the energy at a distance, similar to a reader and a tag. Thus, if the tag's electronics applies a load to its own antenna coil and varies it over time, a signal can be encoded as tiny variations in the magnetic field strength representing the tag's ID. The reader can then recover this signal by monitoring the change in current through the reader coil. A variety of modulation encodings are possible depending on the number of ID bits required, the data transfer rate, and additional redundancy bits placed in the

code to remove errors resulting from noise in the communication channel. Near-field coupling is the most straightforward approach for implementing a passive RFID system. This is why it was the first approach taken and has resulted in many subsequent standards, such as ISO 15693 and 14443, and a variety of proprietary solutions. However, near-field communication has some physical limitations. The range for which we can use magnetic induction approximates to $c/2\pi f$, where c is a constant (the speed of light) and f is the frequency. Thus, as the frequency of operation increases, the distance over which near-field coupling can operate decreases. A

further limitation is the energy available for induction as a function of distance from the reader coil. The magnetic field drops off at a factor of 1/r3, where r is the separation of the tag and reader, along a center line perpendicular to the

coil's plane. So, as applications require more ID bits as well as discrimination between multiple tags in the same locality for a fixed read time, each tag requires a higher data rate and thus a higher operating frequency. These design pressures have led to new passive RFID design. Far-field RFID tags based on far-field emissions capture EM waves propagating from a dipole antenna attached to the reader. A smaller dipole antenna in the tag receives this energy as an alternating potential difference that appears across the arms of the dipole. A diode can rectify this potential and link it to a capacitor, which will result in an accumulation of energy in order to power its electronics. However, unlike the inductive designs, the

tags are beyond the range of the readers near field, and information can't be transmitted back to the reader using load modulation. The technique designers use for commercial far-field RFID tags is back scattering. If they design an antenna with precise dimensions, it can be tuned to a frequency and absorb most of the energy that reaches it at that frequency. However, if an impedance mismatch occurs at this frequency, the antenna will reflect some of the energy (as tiny waves) toward the reader, which can then detect the

energy using a sensitive radio receiver. By changing the antenna's impedance over time, the tag can reflect more or less of the incoming signal in a pattern that encodes the tag's ID. In practice, you can detune a tag's antenna for this purpose by placing a transistor across its dipole and then turning it partially on and off. As a rough design guide, tags that use far-field principles operate at greater than 100 MHz typically in the ultra-high- frequency (UHF) band (such as 2.45 GHz); below this frequency is the

domain of RFID based on near-field coupling. A far-field system's range is limited by the amount of energy that reaches the tag from the reader and by how sensitive the reader's radio receiver is to the reflected signal. The actual return signal is very small, because it's the result of two attenuations, each based on an inverse square law—the first attenuation occurs as EM waves radiate from the reader to the tag, and the second when reflected waves travel back from the tag to the reader. Thus, the returning energy is 1/r4 (again, r is the separation of the tag and reader). Fortunately, thanks to Moore's law and the shrinking feature size of semiconductor manufacturing, the energy required to power a tag at a given frequency continues to decrease (currently as low as a few microwatts). So, with modern semiconductors, we can design tags that can be read at increasingly greater distances than were possible a few years ago. Furthermore, inexpensive radio receivers have been developed with improved sensitivity so they can now detect signals, for a reasonable cost, with power levels on the order of – 100 dBm in the 2.4-GHz band. A typical far-field reader can successfully interrogate tags 3 m away, and some RFID companies claim their products have read ranges of up to 6 m. EPCglobal's work was key to promoting the design of UHF tags, which has been the basis of RFID trials at both Walmart and Tesco. EPCglobal was originally the MIT Auto-ID Centre, a non-profit organization set up by the MIT Media Lab. The center later divided into Auto-ID labs, still part of MIT, and EPCglobal, a commercial company. This company has defined an extensible range of tag standards, but its Class-1 Generation-1 96-bit tag is the one receiving the most attention of late. This tag can label over 50 quadrillion (50 1015) items, making it possible to uniquely label every manufactured item for the foreseeable future—not just using generic product codes.

This isn't necessary for basic inventory control, but it has implications for tracing manufacturing faults and stolen goods and for detecting forgery. It also offers the more controversial post-sale marketing opportunities, enabling direct marketing based on prior purchases.

3.1.8: RFID COMMUNICATION

1. Host manages Reader(s) and issues Commands
2. Reader and tag communicate via RF signal

3.Carrier signal generated by the reader

4. Carrier signal sent out through the antennas
5. Carrier signal hits tag(s) Tag receives and modifies carrier signal –

―sends back‖ modulated signal (Passive Backscatter – also referred to as ―field disturbance device‖).

6. Antennas receive the modulated signal and send them to the Reader.
7. Reader decodes the data.
8. Results returned to the host application.

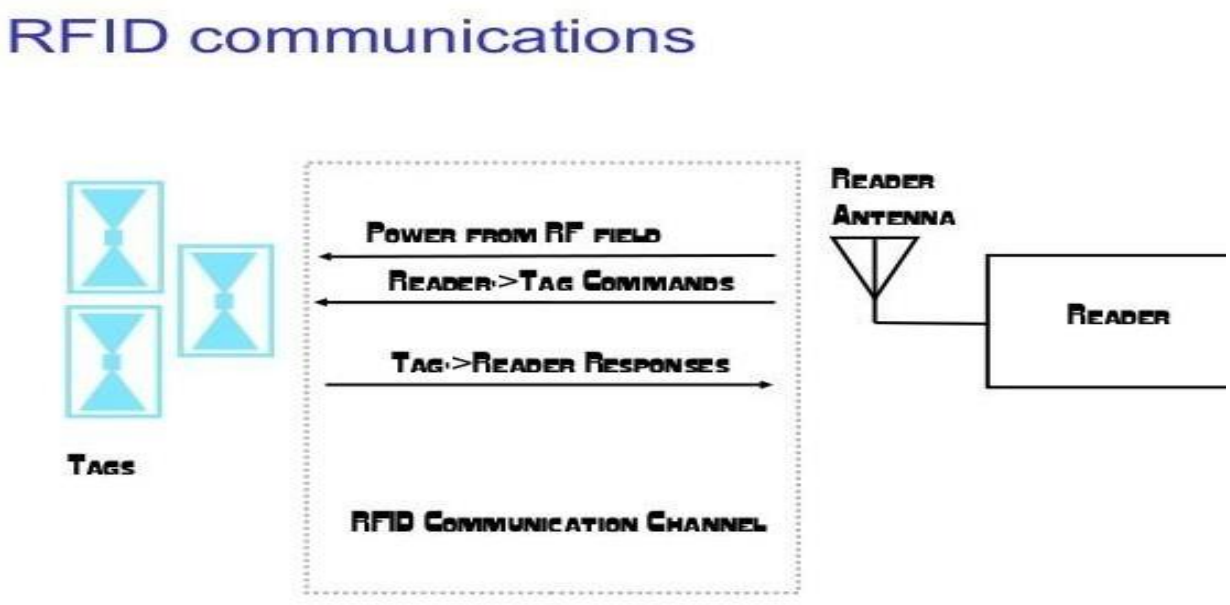

Figure 3.3 RFID Communication

3.2: Raspberry Pi:

Raspberry Pi 3 Model B was released in February 2016 with a **1.2 GHz 64-bit quad core ARM Cortex-A53 processor**, on-board 802.11n Wi-Fi, Bluetooth and USB boot capabilities. ... Other features are Power over Ethernet (PoE) (with the add-on PoE HAT), USB boot and network boot (an SD card is no longer required).

Raspberry Pi is a series of low-cost, single-board computers developed by the Raspberry Pi Foundation. The first Raspberry Pi was released in 2012, and since then, the Raspberry Pi has become incredibly popular in the maker community, as well as among educators and hobbyists.

The Raspberry Pi is a credit-card sized computer that can run a variety of operating systems, including Linux, Windows 10 IoT Core, and Chrome OS. It is powered by a Broadcom System on a Chip (SoC), which includes a CPU, GPU, and RAM. The Raspberry Pi also includes a variety of input and output ports, including USB ports, HDMI, Ethernet, and GPIO (General Purpose Input/Output) pins.

Technical Specification:

1) Broadcom BCM2837 64bit ARMv7 Quad Core Processor powered Single Board Computer running at 1.2GHz
2) 1GB RAM BCM43143 Wi-Fi on board
3) Bluetooth Low Energy (BLE) on board
4) 40pin extended GPIO 4 x USB 2 ports
5) 4 pole Stereo output and Composite video port
6) Full size HDMI
7) CSI camera port for connecting the Raspberry Pi camera
8) DSI display port for connecting the Raspberry Pi touch screen display
9) Micro SD port for loading your operating system and storing data
10) Upgraded switched Micro USB power source (now supports up to 2.4 Amps)
11) Expected to have the same form factor has the Pi 2 Model B, however the LEDs will change position

Pin Description

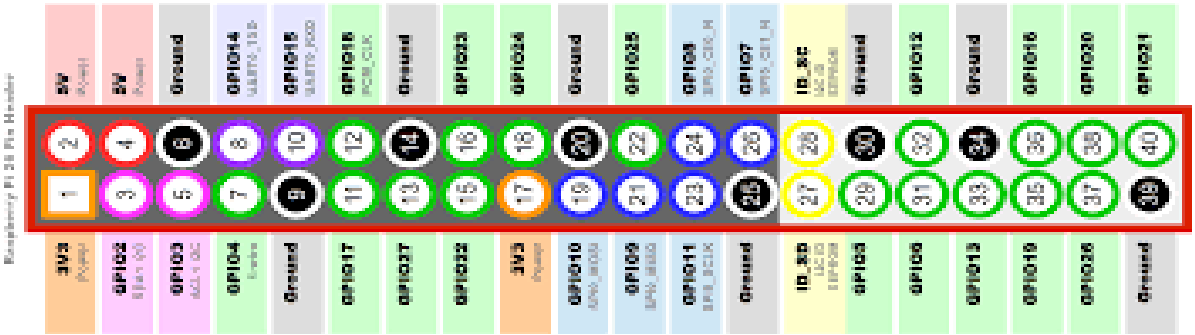

Fig 3.4 Pin Description of Raspberry-pi

The Raspberry Pi has a set of General-Purpose Input/Output (GPIO) pins that allow users to interface with the board and connect external devices. These pins are located on the edge of the board and are labelled with numbers and/or function descriptions.

Here is a brief description of the Raspberry Pi GPIO pins:

1. 3.3V Power: This pin provides a 3.3V power supply, which can be used to power external devices.

2. 5V Power: This pin provides a 5V power supply, which can be used to power external devices.

3. GPIO2 (SDA): This pin is used for I2C communication, which is a popular protocol used to connect sensors and other devices.

4. 5V Power: This pin provides a 5V power supply, which can be used to power external devices.

5. GPIO3 (SCL): This pin is also used for I2C communication.

6. Ground: This pin is connected to ground.

7. GPIO4: This pin can be used as a general-purpose input or output.

8. GPIO14 (TXD): This pin is used for serial communication.

9. Ground: This pin is connected to ground.

10. GPIO15 (RXD): This pin is also used for serial communication.

11. GPIO17: This pin can be used as a general-purpose input or output.

12. GPIO18 (PCM_CLK): This pin is used for Pulse Code Modulation (PCM) audio output.

13. GPIO27: This pin can be used as a general-purpose input or output.

14. Ground: This pin is connected to ground.

15. GPIO22: This pin can be used as a general-purpose input or output.

16. GPIO23: This pin can be used as a general-purpose input or output.

17. 3.3V Power: This pin provides a 3.3V power supply, which can be used to power external devices.

18. GPIO24: This pin can be used as a general-purpose input or output.

19. GPIO10 (MOSI): This pin is used for SPI communication, which is a popular protocol used to connect sensors and other devices.

20. Ground: This pin is connected to ground.

21. GPIO9 (MISO): This pin is also used for SPI communication.

22. GPIO25: This pin can be used as a general-purpose input or output.

23. GPIO11 (SCLK): This pin is also used for SPI communication.

24. GPIO8 (CE0): This pin is used for SPI communication.

25. Ground: This pin is connected to ground.

26. GPIO7 (CE1): This pin is also used for SPI communication.

It is important to note that the functionality of these pins can be changed through software programming, allowing for a wide range of uses and applications. Additionally, the Raspberry Pi has other pins and interfaces for other types of communication and connectivity, such as USB, HDMI, and Ethernet.

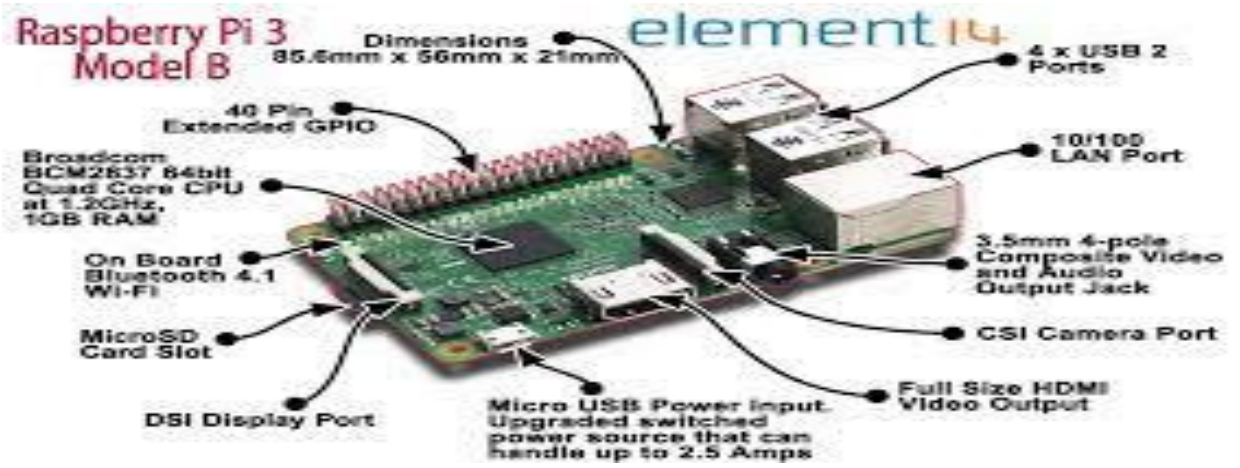

Fig 3.5 Model of Raspberry-pi

The process of booting a Raspberry Pi can be broken down into several steps:

1. Power on the Raspberry Pi: When the Raspberry Pi is powered on, the CPU on the board begins executing the code stored in the boot ROM.

2. Bootloader: The boot ROM loads a small program called the bootloader from the SD card or other bootable device connected to the Raspberry Pi. The bootloader is responsible for loading the operating system and preparing the Raspberry Pi for use.

3. Operating System: The bootloader loads the operating system kernel, which is the core of the operating system. The kernel initializes the hardware on the Raspberry Pi and starts necessary processes and services.

4. Filesystem: The operating system then mounts the filesystem and starts any additional services or daemons required for the system to function properly.

5. User Interface: Once the operating system has booted, it typically loads a user interface or graphical environment, such as the desktop environment, which allows the user to interact with the Raspberry Pi and run applications.

Overall, the process of booting a Raspberry Pi is similar to booting a traditional desktop computer, with the main difference being that the Raspberry Pi's bootloader and operating system are typically stored on an SD card or other external device rather than on internal storage.

When you power on a Raspberry Pi, it first checks the boot ROM, which is a small piece of firmware that is built into the Raspberry Pi's hardware. The boot ROM checks for a bootable device, such as an SD card, and reads the first sector of the device to find the bootloader.

The bootloader is a small program that is responsible for initializing the hardware on the Raspberry Pi, setting up the memory and CPU, and loading the operating system kernel into memory. The bootloader is also responsible for configuring the kernel's boot parameters, such as the root file system, and setting up any necessary drivers for peripherals such as keyboards, mice, and displays.

Once the bootloader has finished loading the kernel, the kernel takes over and begins the process of initializing the rest of the hardware and starting necessary system services. This includes loading device drivers, mounting the file system, and launching system daemons.

After the operating system has finished booting, it typically loads a user interface or graphical environment, such as a desktop environment, which allows the user to interact with the Raspberry Pi and run applications. From here, the Raspberry Pi can be used for a wide variety of tasks, such as running servers, programming projects, or multimedia applications.

Overall, the process of booting a Raspberry Pi is a multi-stage process that involves the hardware, firmware, bootloader, kernel, and operating system. Each stage is critical to the successful booting of the Raspberry Pi, and any issues with any of these stages can cause the system to fail to boot properly.

3.3: Camera Module:

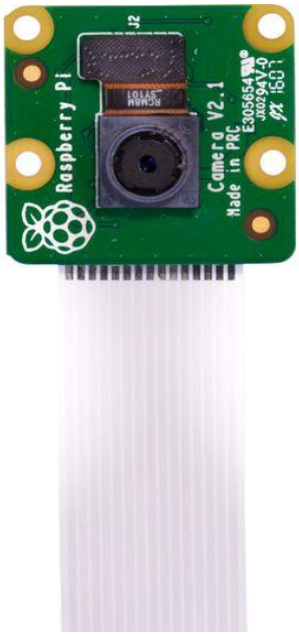

Fig 3.6 Camera Module

The Raspberry Pi camera is a small, affordable, and versatile camera module that is designed specifically for use with Raspberry Pi single-board computers. It features a high-quality sensor that is capable of capturing images and video in a variety of resolutions, from 640x480 up to 3280x2464 pixels. The camera is available in two versions, the original Raspberry Pi Camera Module, and the Raspberry Pi Camera Module V2, which features improved image quality and a wider field of view.

The camera can be connected to the Raspberry Pi using the CSI (Camera Serial Interface) port, which is a dedicated camera connector on the Raspberry Pi board. The camera module can be controlled using software libraries such as the Pi camera library, which allows you to capture images and video, and adjust camera settings such as brightness, contrast, and exposure.

The Raspberry Pi camera module is commonly used in a variety of applications, including home automation, security systems, robotics, and computer vision projects. It can be used to capture images and video for time-lapse photography, surveillance, or even live streaming. Additionally, the camera module is compatible with a wide range of accessories, including lenses, tripods, and cases, which makes it a highly versatile tool for any Raspberry Pi project.

3.4: Wiper Motor:

Fig 3.7 Structure of Wiper Motor

A wiper motor is an electric motor that is used to power the windshield wipers in a vehicle. The motor is typically located under the hood, near the base of the windshield, and is connected to the wiper linkage via a series of gears and levers.

The wiper motor receives electrical power from the vehicle's battery, which is controlled by the wiper switch on the steering column or dashboard. When the switch is activated, the wiper motor rotates a crankshaft that moves the wiper arms back and forth across the windshield, clearing away rain, snow, and debris.

Most wiper motors are designed to operate at different speeds, depending on the weather conditions and the driver's preference. The motor may have multiple speed settings, and may also include an intermittent wiper function that allows the wipers to operate at a set interval.

In addition to the basic function of moving the wiper blades, some wiper motors may also include additional features such as automatic park, which moves the wipers to a specific position when they are turned off, and rain-sensing technology, which adjusts the wiper speed based on the amount of moisture on the windshield.

Overall, the wiper motor is a critical component of the vehicle's safety system, helping to ensure that the driver's view of the road remains clear in all weather conditions.

Software Specification:

I] Web App - A Web app is provided to customers to facilitate the shopping experience. It allows customers to create shopping lists, scan products, and make payments using their mobile devices. At present there is system available that contain mobile application. That mobile application has functionality like connecting with trolley with WIFI module that process is not worthy nowadays that's why introducing a web application which display on each trolley with the help Tab having 20-inch screen. In web application there is multiple functionalities like creating items lists, generating a bill, multiple payment option and for customer guide we added chatbot.

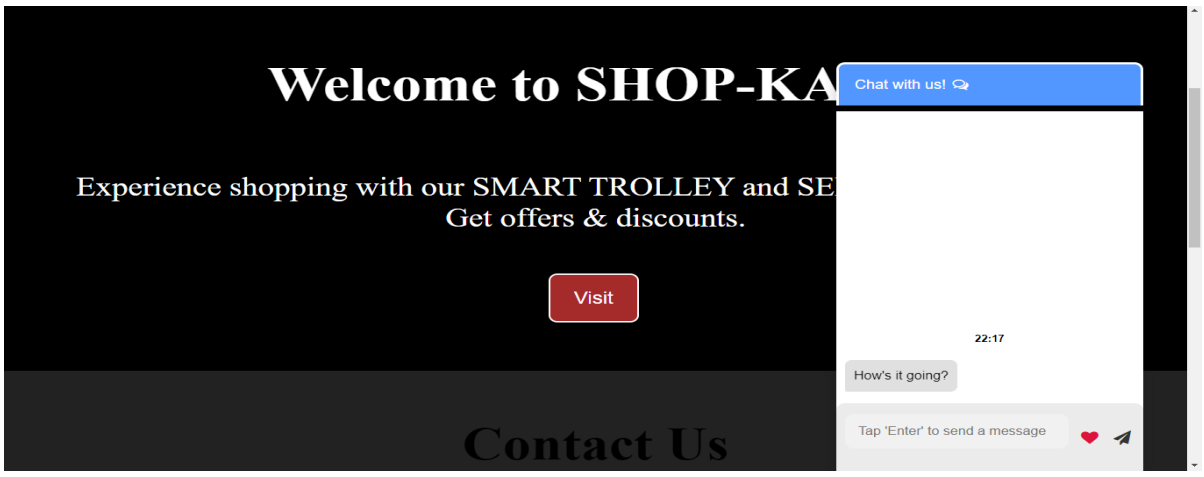

Fig 3.8 User Interface of Web-application

II] POS System - The POS system is used to process payments and manage inventory levels in real-time. In Web-application multiple payment option is there like G-pay, Phone-pay, all are integrated with our web application that's why is working in real time smoothly.

A Point of Sale (POS) system is a software and hardware solution used to manage sales transactions between a business and its customers. POS systems are commonly used in retail stores, restaurants, and other businesses where goods or services are sold.

A typical POS system includes several components, including a computer or tablet, a cash register, barcode scanner, and payment processing equipment. The software used in a POS system is designed to manage inventory, track sales, and process payments.

When a customer purchases a product or service, the transaction is entered into the POS system by the cashier or salesperson. The system then calculates the total amount due, including any taxes or discounts, and prompts the customer to pay using a payment method such as cash, credit card, or mobile payment.

The POS system then sends the payment information to the payment processor, which verifies the payment and transfers funds from the customer's account to the business's account. The POS system also updates the business's inventory system to reflect the items that have been sold.

In addition to managing sales transactions, POS systems can also be used to generate reports and analyze sales data. Business owners can use this data to track inventory levels, identify popular products, and make informed decisions about pricing, marketing, and sales strategies.

Overall, POS systems are an important tool for businesses of all sizes, as they provide a streamlined and efficient way to manage sales transactions and track inventory levels. By automating many of the tasks associated with sales and inventory management, businesses can save time and reduce errors, allowing them to focus on other aspects of their operations.

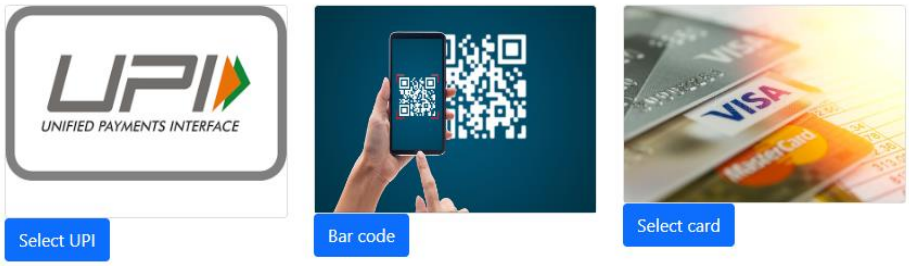

Fig 3.9 Payment Option

III] Chatbot:

A chatbot in a smart trolley is an artificial intelligence program that is designed to interact with customers and provide assistance in a shopping environment. The chatbot can be integrated into the trolley using a touchscreen display or through a mobile app, and can help customers with a variety of tasks, such as locating products, providing recommendations, and answering questions about pricing and availability. The chatbot in a smart trolley can use natural language processing (NLP) technology to understand and interpret the customer's requests and respond in a conversational manner. The chatbot can also be programmed with knowledge about the store's layout and inventory, allowing it to provide accurate and helpful information to customers. One of the benefits of a chatbot in a smart trolley is that it can help customers navigate the store more efficiently, reducing the amount of time they spend searching for products and improving their overall shopping experience. Additionally, the chatbot can be programmed to provide personalized recommendations based on the customer's purchase history and preferences, helping to increase sales and customer satisfaction.

Overall, the integration of a chatbot in a smart trolley is a way to leverage artificial intelligence and enhance the customer experience in a retail environment.

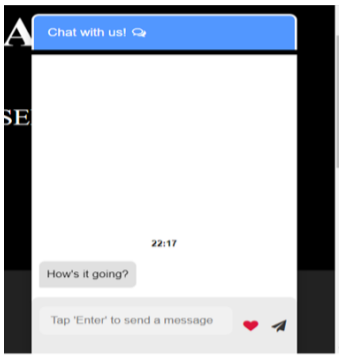

Fig 4.1 Chatbot for Customer Guidance

CHAPTER 4 METHODOLOGY

4.1: Hardware Component

4.1.1 Trolley - The trolley is equipped with sensors, cameras, and other necessary hardware to enable the system's functionality. It also includes a display screen that displays product information, promotions, and pricing. Material used for making trolley was a wood, there around 5kg of weight which quite lighter, that lighter weight was used because it will helped move forward and backward using a motor having high torque. Trolley contains one plane board space that will used for a placing TAB, that Tab was used for displaying a web application which very much user friendly. This makes trolley having multiple functionality and features which will useful for customer.

4.1.2: Scanner –

RFID (Radio Frequency Identification) scanner technology is a type of wireless communication technology that uses radio waves to read and capture information stored on RFID tags or labels. RFID technology has become increasingly popular in recent years, particularly in retail, transportation, and logistics industries.

An RFID scanner consists of two main components: a reader and an antenna. The reader sends out a radio frequency signal, which is picked up by the antenna of an RFID tag located nearby. The RFID tag contains a small microchip and an antenna, which enables it to receive and respond to the radio frequency signal sent by the reader.

When the RFID tag receives the signal from the reader, it sends back a response that contains information stored on the tag, such as the product name, price, and location. The reader then captures this information and sends it to a computer or other device for processing and analysis.

One of the key advantages of RFID technology is that it allows for automated and accurate inventory tracking. For example, in a retail store, RFID tags can be attached to each product, and an RFID scanner can be used to quickly and accurately track the location and movement of each item. This can help to reduce errors and improve efficiency in managing inventory.

RFID technology can also be used for other applications, such as asset tracking, security, and access control. For example, RFID tags can be attached to valuable assets, such as laptops or equipment, to help prevent theft or loss.

Overall, RFID scanner technology is a powerful tool for businesses and organizations looking to automate and streamline their operations. With its ability to capture and analyze data quickly and accurately, RFID technology can help to reduce errors, improve efficiency, and provide valuable insights into business operations.

4.1.3: Payment Processing System - The payment processing system allows customers to pay for their purchases using various methods such as credit/debit cards, mobile payments or cash. Payment system which is built on Web application that will help to customer pay easily through different UPI and Card Functionality is available on a web application Basically, auto generated bill amount display on web application after displaying amount on web app customer will recognize that much amount, he/she need to pay.

4.1.4: Sensors - Sensors are placed on the trolley to detect the presence of items and monitor the inventory level in real-time. In this system we are using primary sensor RFID sensor which can able to scan the details which is placed on RFID TAG. RFID tag contain small circuit which is able to transmit radio wave and that radio waves detect by RFID scanner, that scanner interfacing with Raspberry-pi using SPI protocol.

4.1.5: Cameras – The Raspberry Pi camera is a small, affordable, and versatile camera module that is designed specifically for use with Raspberry Pi single-board computers. It features a high-quality sensor that is capable of capturing images and video in a variety of resolutions, from 640x480 up to 3280x2464 pixels. The camera is available in two versions, the original Raspberry Pi Camera Module, and the Raspberry Pi Camera Module V2, which features improved image quality and a wider field of view.

The camera can be connected to the Raspberry Pi using the CSI (Camera Serial Interface) port, which is a dedicated camera connector on the Raspberry Pi board. The camera module can be controlled using software libraries such as the Pi camera library, which allows you to capture images and video, and adjust camera settings such as brightness, contrast, and exposure.

The Raspberry Pi camera module is commonly used in a variety of applications, including home automation, security systems, robotics, and computer vision projects. It can be used to capture images and video for time-lapse photography, surveillance, or even live streaming. Additionally, the camera module is compatible with a wide range of accessories, including lenses, tripods, and cases, which makes it a highly versatile tool for any Raspberry Pi project.

4.1.6: Remote Movement – Remote movement using a relay module and wiper motor involves using a relay module to control the direction and speed of a wiper motor. A wiper motor is a type of electric motor commonly used in automobiles to move the windshield wipers.

To control the movement of the wiper motor remotely, a relay module is used to switch the motor on and off, as well as change the direction and speed of the motor. The relay module is connected to a microcontroller or other control device, which sends signals to the relay module to control the motor.

The wiper motor typically has two terminals that control the direction of the motor. To change the direction of the motor, the relay module is used to switch the polarity of the voltage applied to the motor. For example, to move the motor in one direction, the relay module might apply a positive voltage to one terminal and a negative voltage to the other terminal. To move the motor in the opposite direction, the polarity of the voltage applied to the motor is reversed.

The speed of the wiper motor can also be controlled using the relay module. This is typically done by adjusting the amount of voltage applied to the motor. For example, to increase the speed of the motor, the relay module might apply a higher voltage to the motor. To decrease the speed of the motor, the voltage applied to the motor is lowered.

Overall, remote movement using a relay module and wiper motor is a simple and effective way to control the movement of a motor from a remote location. This technique can be used in a wide range of applications, including robotics, automation, and industrial control systems.

4.2 Software Components:

4.2.1: Web App - A Web app is provided to customers to facilitate the shopping experience. It allows customers to create shopping lists, scan products, and make payments using their mobile devices. At present there is system available that contain mobile application. That mobile application has functionality like connecting with trolley with WIFI module that process is not worthy nowadays that's why introducing a web application which display on each trolley with the help Tab having 20-inch screen. In web application there is multiple functionalities like creating items lists, generating a bill, multiple payment option and for customer guide we added chatbot.

4.2.2: POS System - The POS system is used to process payments and manage inventory levels in real-time. In Web-application multiple payment option is there like G-pay, Phone-pay, all are integrated with our web application that's why is working in real time smoothly.

A Point of Sale (POS) system is a software and hardware solution used to manage sales transactions between a business and its customers. POS systems are commonly used in retail stores, restaurants, and other businesses where goods or services are sold.

A typical POS system includes several components, including a computer or tablet, a cash register, barcode scanner, and payment processing equipment. The software used in a POS system is designed to manage inventory, track sales, and process payments.

When a customer purchases a product or service, the transaction is entered into the POS system by the cashier or salesperson. The system then calculates the total amount due, including any taxes or discounts, and prompts the customer to pay using a payment method such as cash, credit card, or mobile payment.

The POS system then sends the payment information to the payment processor, which verifies the payment and transfers funds from the customer's account to the business's account. The POS system also updates the business's inventory system to reflect the items that have been sold.

In addition to managing sales transactions, POS systems can also be used to generate reports and analyze sales data. Business owners can use this data to track inventory levels, identify popular products, and make informed decisions about pricing, marketing, and sales strategies.

Overall, POS systems are an important tool for businesses of all sizes, as they provide a streamlined and efficient way to manage sales transactions and track inventory levels. By automating many of the tasks associated with sales and inventory management, businesses can save time and reduce errors, allowing them to focus on other aspects of their operations.

4.3 Block Diagram:

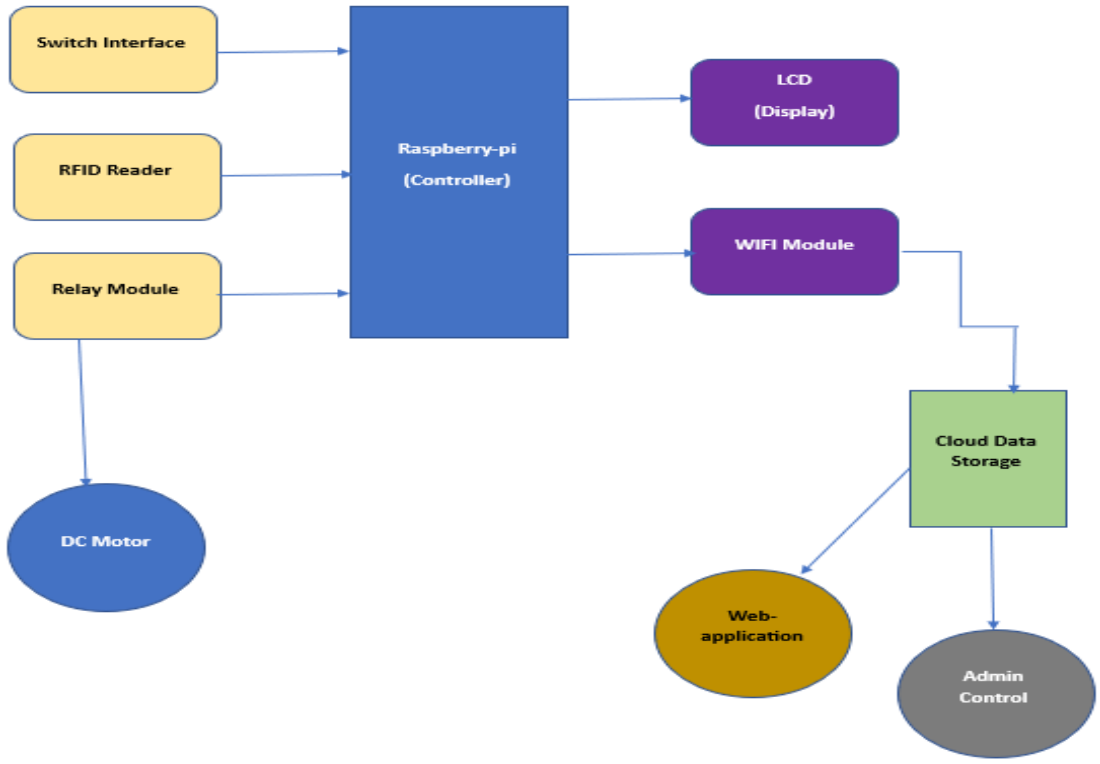

Fig 4.2 Block Diagram of Smart Trolley

4.4 RFID Technology:

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Overall, RFID scanner technology is a powerful tool for businesses and organizations looking to automate and streamline their operations. With its ability to capture and analyze data quickly and accurately, RFID technology can help to reduce errors, improve efficiency, and provide valuable insights into business operations.

4.5 Web Development:

Web development technology refers to the tools, languages, frameworks, and methodologies used to create web applications and websites. There are several technologies involved in web development, and each serves a specific purpose.

Here are some of the main technologies used in web development:

1. HTML: HTML (Hypertext Markup Language) is a markup language used to structure content on the web. It provides the basic structure for web pages, defining elements such as headings, paragraphs, and lists.

2. CSS: CSS (Cascading Style Sheets) is used to define the visual appearance of web pages. It is used to style HTML elements by defining properties such as color, font, and layout.

3. JavaScript: JavaScript is a programming language used to create interactive and dynamic web pages. It is used to add functionality to web pages, such as form validation, animations, and user interactions.

4. Frameworks: Frameworks such as React, Angular, and Vue are used to build complex web applications and websites. They provide a set of pre-built components and libraries that can be used to speed up development.

5. Back-end technologies: Back-end technologies such as PHP, Ruby on Rails, and Node.js are used to build the server-side of web applications. They are used to handle database operations, process user inputs, and perform other server-side tasks.

6. Databases: Databases such as MySQL, MongoDB, and PostgreSQL are used to store and manage data for web applications. They provide a way to store and retrieve data from web applications, and are used to power many web applications.

7. APIs: APIs (Application Programming Interfaces) are used to allow different applications to communicate with each other. They provide a way for web applications to interact with other systems and services.

Overall, web development technology is constantly evolving, and developers must keep up with the latest trends and tools to create effective and efficient web applications and websites. By using the right technologies and tools, web developers can create engaging, dynamic, and interactive web experiences for users.

4.6 Working Flow:

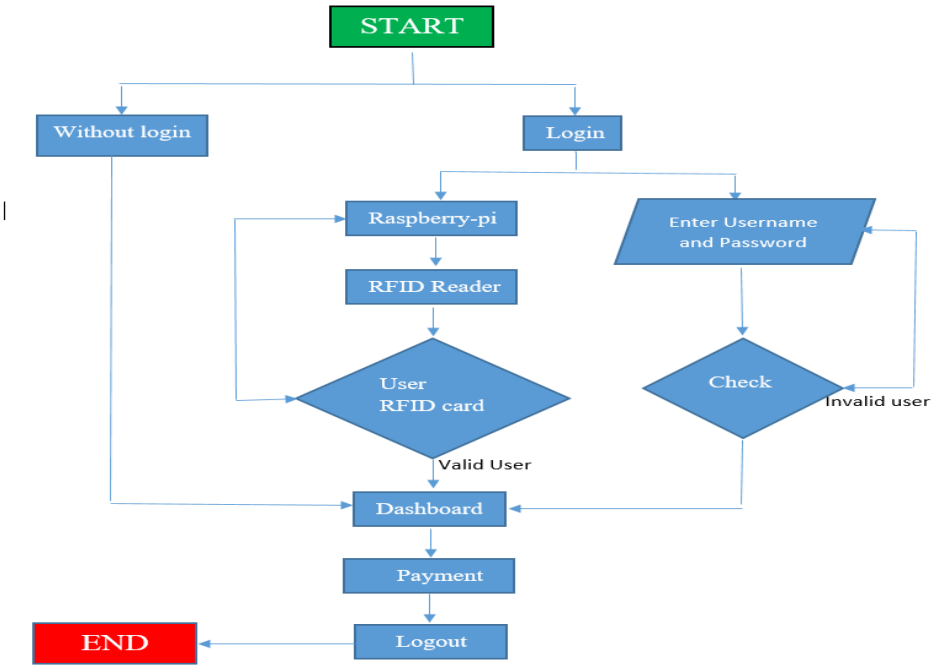

Fig 4.3 Work Flow of Smart Trolley

1] Product Tagging: Each product in the store is tagged with an RFID tag containing a unique identifier.

2] RFID Reader: The RFID reader is placed on the trolley and is used to read the RFID tags as the customer places items in the trolley.

3] Web Application: The RFID reader sends the information about the products to the web application running on a server. The web application processes the information and updates the customer's virtual shopping cart in real-time.

4] Virtual Shopping Cart: The virtual shopping cart can be accessed by the customer using a touchscreen display on the trolley or a mobile app. It shows the customer the items they have added to their cart, along with the price and running total.

5] Additional Information: The web application can provide additional information to the customer, such as the location of the products in the store and whether they are on sale or out of stock.

6] Mobile Payment: When the customer is ready to check out, they can pay for their items using a mobile payment system, such as Apple Pay or Google Wallet.

7] Inventory Management: After the transaction is complete, the web application updates the store's inventory management system to reflect the items that were purchased.

Overall, a smart trolley using RFID and web development can provide a convenient and efficient shopping experience for customers, while also improving inventory management for retailers.

CHAPTER 5 RESULT AND DISCUSSION

Based on the proposed framework, smart trolley with automatic billing, theft prevention or error avoidance using Raspberry pi and the billed items are displayed on the LCD display mounted in the trolley. The following are screenshots from the Web-application "E-cart" where the grocery items selection, mode of payment, as well as a customer's Id and trolley number can be displayed and accessed by the user as per the fig 6, fig 7, fig 8 and fig 9 respectively. Whereas from the admin side, collection of grocery list and updating the available grocery list to the customer, and allocation of customer name and trolley number to the customer can be done.

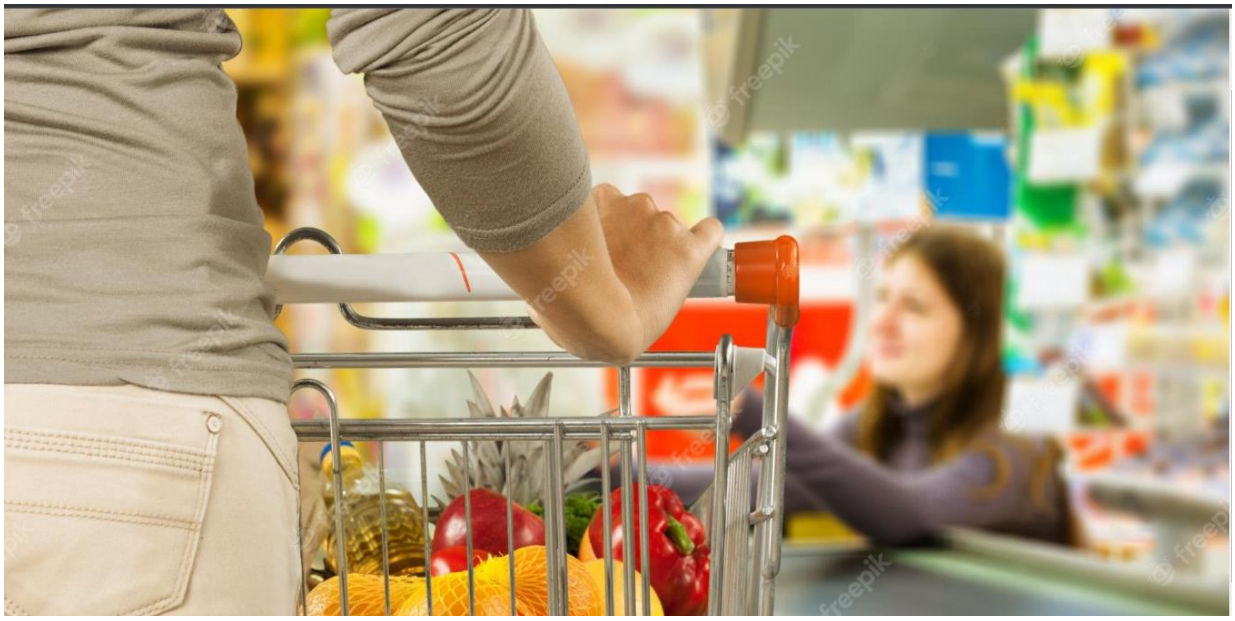

Fig 5.1 User Interface of Web-application

Fig 5.2 Proposed Model

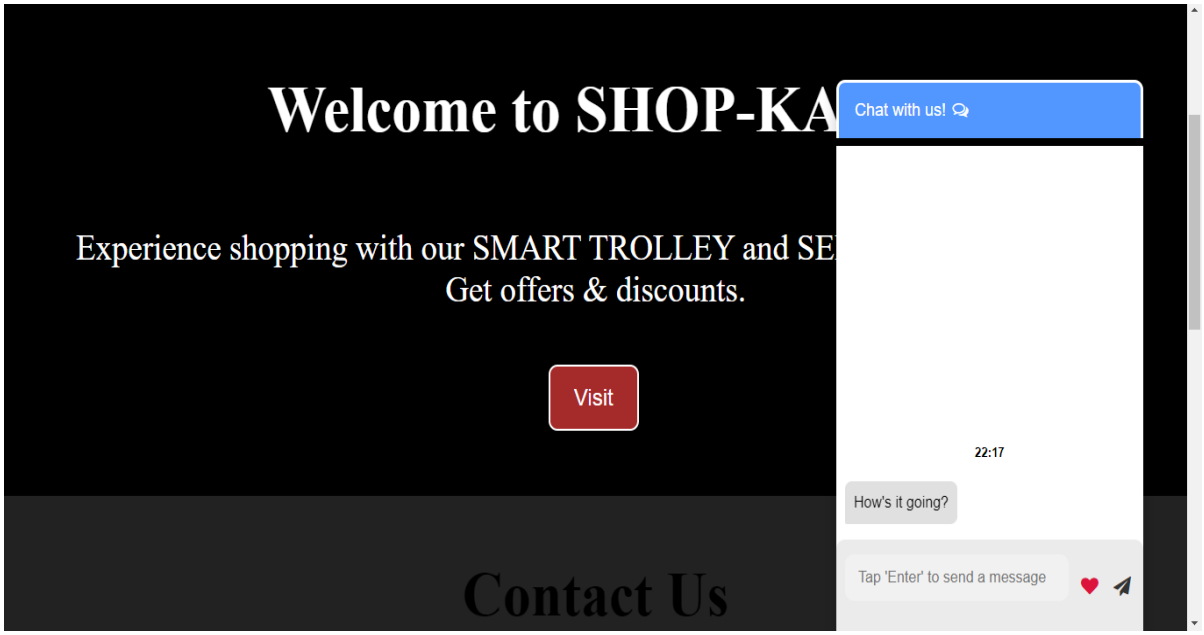

Fig 5.3 Chatbot for Customer Guidance

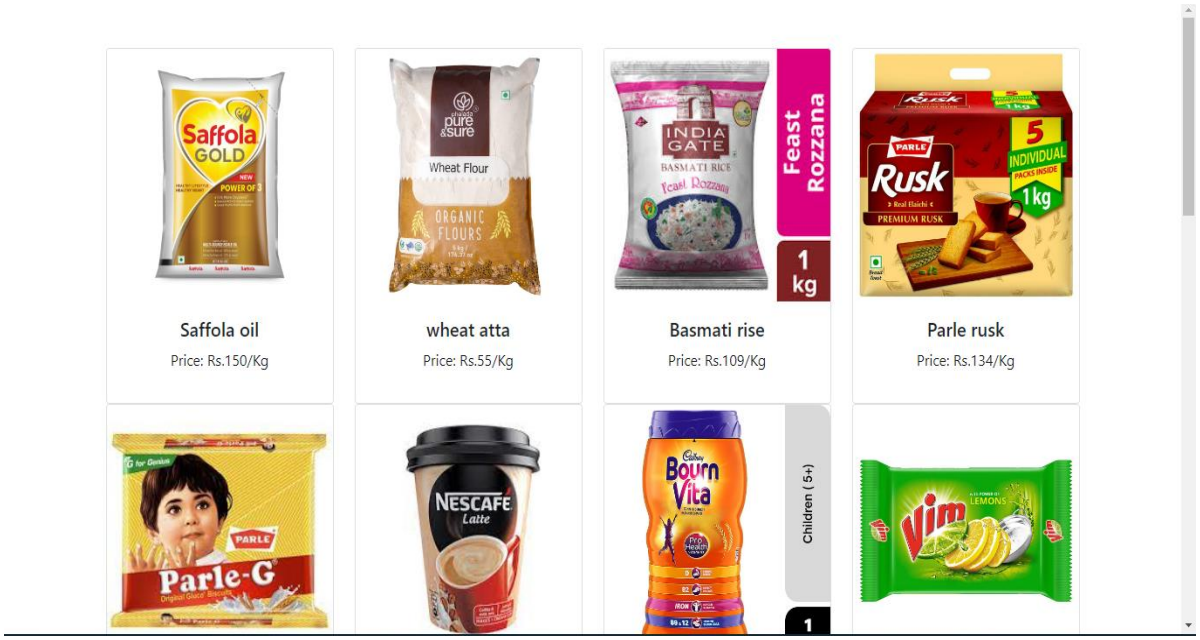

Fig 5.4 Available Product in Mart

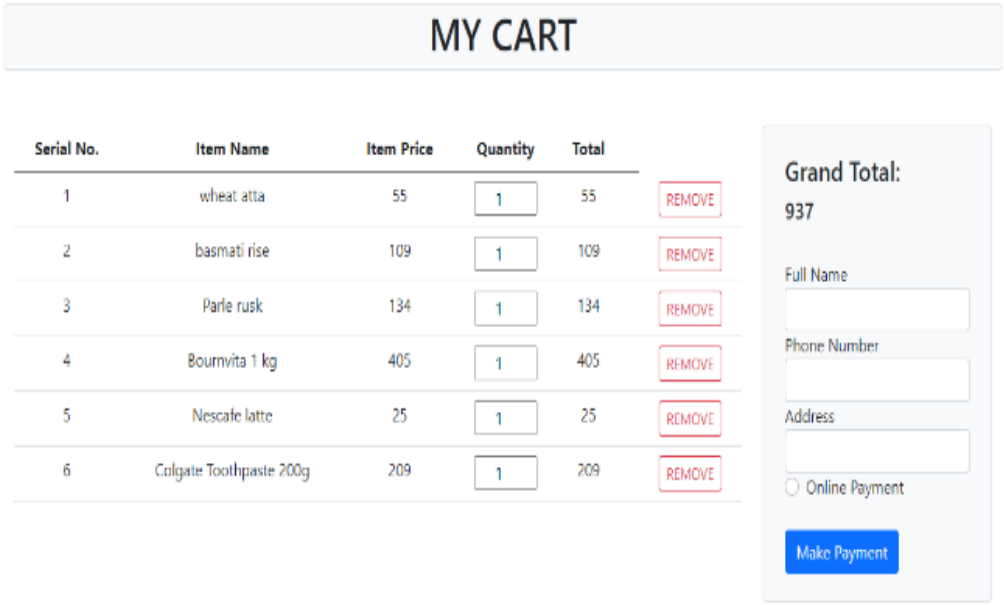

Fig 5.5 Generating Tentative List of Product

Fig 5.6 Payment Option

- **Customer Experience:**
  One of the primary benefits of a smart trolley is to improve the shopping experience for customers. Metrics such as average shopping time, number of items purchased per visit, and customer satisfaction ratings can be used to evaluate the success of the system. Additionally, feedback from customers through surveys or focus groups can be used to identify areas for improvement or additional features that would enhance the user experience.
- **Sales:**
  Smart trolleys can be used to increase sales by providing personalized recommendations to customers, promoting sales or discounts, and making it easier to find products. Retailers can track metrics such as average order value, conversion rates, and revenue to determine the impact of the smart trolley on their bottom line.
- **Inventory Management:**
  By tracking the products added to the trolley in real-time, smart trolleys can help retailers better manage their inventory. This can reduce waste and prevent out-of-stock situations that might lead to lost sales. Metrics such as inventory accuracy, turnover rate, and stockouts can be used to evaluate the effectiveness of the system.
- **Operational Efficiency**:
  Smart trolleys can also improve operational efficiency by reducing the need for staff to manually process transactions and restock shelves. Retailers can track metrics such as transaction time, employee productivity, and labor costs to determine the impact of the smart trolley on their operations.
  Overall, the results and discussions of a smart trolley will depend on the specific goals and objectives of the system. By tracking key metrics and gathering feedback from customers and employees, retailers can identify areas for improvement and optimize the performance of the smart trolley over time.

CHAPTER 6 SUMMARY, CONCLUSION AND FUTURE SCOPE

6.1 SUMMARY

A smart trolley is a technological solution that aims to enhance the shopping experience for customers while improving operational efficiency and inventory management for retailers.

Functionality:

Smart trolleys can offer a variety of features and functionalities beyond just RFID tracking and a web application. For example, some smart trolleys may include a barcode scanner for customers to scan items themselves, or a display screen to show product information, promotions, and recommendations. Some smart trolleys may also include a mobile app for customers to access their virtual shopping cart and make payments, or even offer features like voice-activated shopping or augmented reality product visualization.

Data Analytics:

One of the key benefits of a smart trolley system is the ability to collect and analyze data about customer behavior, product sales, and inventory management. Retailers can use this data to optimize their operations, make informed business decisions, and improve the overall shopping experience for customers. For example, data analytics might reveal which products are frequently added to customers' virtual shopping carts, which products are often left behind, or which products are out of stock most frequently. This information can then be used to adjust product offerings, promotions, and inventory management strategies.

Security:

Because smart trolleys are connected to a web application and potentially to mobile devices, security is a critical consideration for these systems. Retailers must ensure that sensitive customer data, such as payment information, is protected from unauthorized access. Additionally, retailers must ensure that the RFID tags and readers are secure and not susceptible to tampering or hacking. To address these security concerns, smart trolley systems may use encryption, secure authentication protocols, and physical security measures.

Integration with Other Systems:

Smart trolley systems can be integrated with other retail systems, such as point-of-sale systems, inventory management systems, and customer relationship management (CRM) systems. This integration can provide additional benefits, such as real-time inventory tracking, seamless checkout processes, and personalized marketing campaigns based on customer shopping habits.

Overall, smart trolleys offer a wide range of functionalities and benefits for both customers and retailers. By providing a more convenient and efficient shopping experience, while also improving operational efficiency and inventory management, smart trolleys can help retailers stay competitive in a rapidly evolving retail landscape.

6.2 CONCLUSION

The advancement in science and technology is a persistent process. Latest gadgets and latest technology are being designed and developed. This application is used in shopping malls for assisting customers by saving a lot of time in buying commodities. In this project RFID is used as safety access for the item which thereby enhances the surveillance performance. This implementation initiates for an automated central billing system in shopping malls and supermarkets. With this, shoppers no longer have to wait near counters for payment of bills because of their purchased item information getting transferred to central billing unit. By this billing process speed increases and becomes much simpler. In addition to this capability, the mechanism also assures recognition of cases of theft induced by fraudulent consumers which makes the system more reliable and fascinating to both customers as well as sellers. This will enhance the shopping experience to a new level.

Different variables like item cost, item name etc. are continuously displayed on LCD attached to the trolley. Thus, we can say that automatic billing of products by using RFID technique will be a more feasible choice in the upcoming days and thereby operation becomes more concise and systematic.

The objective is effectively attained in the prototype model developed. The developed product is of low cost, amiable to use and does not require any specific practice. The ability to take a decision can be done in the cart itself which can be used in the shopping complexes for effortless and clever way of purchasing items to save vitality, time and money of the customers. The project is evaluated with different trial cases with distinct items assessed for all the practical trials. Tags used in this project are of water sensitive so the trolley is restricted to use water sensitive products. And moreover, tags used in this project have the capacity of detecting only one side therefore tags are attached to products in circular fashion in order to avoid non detection. If we can use more powerful tags which are under research, we can overcome this problem. When the evaluation is done with a single shopping trolley with distinct items, it gives the 83% accuracy for all the cases.

6.3 FUTURE SCOPE

The future scope of smart trolleys is quite promising, with several potential advancements and improvements on the horizon. Here are some potential future developments:

I] Artificial Intelligence (AI) Integration: Smart trolleys can be integrated with AI-powered systems to offer even more personalized recommendations to customers based on their shopping history and preferences. This could also help retailers to better understand customer behavior and adjust their product offerings accordingly.

II] Internet of Things (IoT) Integration: Smart trolleys can be integrated with other IoT devices, such as sensors and beacons, to provide even more accurate and real-time data about customer behavior and inventory management.

III] Augmented Reality (AR) Integration: Smart trolleys could incorporate AR technology to allow customers to visualize how products would look in their homes before making a purchase. This could improve the shopping experience and help customers make more informed decisions.

IV] Contactless Payment Options: With the increasing popularity of contactless payment methods, smart trolleys may incorporate features like mobile payments and digital wallets to provide a seamless and secure checkout process.

V] Sustainability Features: Smart trolleys may also incorporate sustainability features, such as the ability to track carbon footprint and recommend more eco-friendly products to customers.

VI] Virtual Reality (VR) Integration: Smart trolleys could incorporate VR technology to provide customers with an immersive shopping experience, allowing them to virtually explore products and try them out before making a purchase.

VII] Predictive Analytics: By analyzing data about customer behavior and trends, smart trolleys could offer predictive analytics to retailers, helping them to anticipate demand and optimize their inventory accordingly.

VIII] Multi-Channel Integration: Smart trolleys could be integrated with other retail channels, such as online shopping and mobile apps, to provide customers with a seamless and consistent shopping experience across all channels.

IX] Personalized Promotions: Smart trolleys could offer even more personalized promotions to customers, using data analytics and machine learning algorithms to recommend products and promotions that are tailored to each individual customer.

X] Enhanced Security: As smart trolleys become more integrated with other systems and devices, it will be important to ensure that security measures are continuously updated and enhanced to protect customer data and prevent cyberattacks.

XI] Cloud-Based Solutions: Smart trolleys could be integrated with cloud-based solutions, allowing for real-time data analytics and processing, as well as seamless integration with other cloud-based systems.

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APPENDIX

Code: -

1] RFID:

```
import RPi.GPIO as GPIO
from mfrc522 import SimpleMFRC522
import MySQLdb
import datetime
GPIO.setwarnings(False)
db = MySQLdb.connect(host="182.50.133.77", user="Kalpesh",passwd="Kalpesh@123",
db="prabudhbharat")
cur = db.cursor()
print("read RF id card")
reader = SimpleMFRC522()
id,text  = reader.read()
print(id)
dr_no = 1
    time.sleep(0.5)

    return a_value
```

2] MOTOR

```
import requests
import RPi.GPIO as GPIO
import time
GPIO.setmode(GPIO.BCM)
m11 = 17   # board  11
m12 = 27   #board   13
m21 = 16   #board  36
m22 = 26   #borad  37

GPIO.setup(m11,GPIO.OUT)
GPIO.setup(m12,GPIO.OUT)
GPIO.setup(m21,GPIO.OUT)
GPIO.setup(m22,GPIO.OUT)

def motor(mp1, mp2, mp3, mp4):
    GPIO.output(m11, mp1)
    GPIO.output(m12, mp2)
    time.sleep(0.01)
    GPIO.output(m21, mp3)
    GPIO.output(m22, mp4)
   GPIO.output(m22, mp4)
    time.sleep(0.5)
```

```
while(1):
    a = "http://tsm.ecssofttech.com/api/SelectToggleCase.php"
    r = requests.get(a)
    x = str(r.content)
    print(x[2])


    if(x[2]== "8"):
        motor(0, 1,0,1)  #forward

    elif(x[2]== "2"):
        motor(1, 0, 1,0 ) #reverse

    elif(x[2]== "6"):
        motor(0, 1, 1,1)   #right

    elif(x[2]== "4"):
    elif(x[2]== "4"):
        motor(1,1,0,1)    #left

    elif(x[2]== "5"):
        motor(1,1,1,1)    #stop
```

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This is to certify that

Dr./Mr./Mrs./Ms. Tejas Patil

of Government College Of Engineering, Karad

Has presented a paper titled "IOT Based Smart Trolley with Automatic Billing System"

in the "40th GISFI STANDARDIZATION SERIES MEETING Jointly with International Conference on 6G and Wireless Network Technologies ", organized by the Department of Electronics and Telecommunication Engineering, Kolhapur Institute of Technology's College of Engineering (Autonomous), Kolhapur held during 3rd - 5th April 2023.

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