Design and Implementation of a Smart Shopping Cart by RFID Technology

by

Nemalidinne Sai Megana

A thesis submitted in partial fulfillment of the requirements for the

degree of Master of Engineering in

Microelectronics and Embedded Systems

Examination Committee: Dr. Mongkol Ekpanyapong (Chairperson)

Assoc. Prof. Erik L. J. Bohez

Dr. A.M. Harsha S. Abeykoon

Nationality: Indian

Previous Degree: Bachelor of Technology in

Electronics and Communications Engineering

Jawaharlal Nehru Technological University, Hyderabad

Telangana, India

Scholarship Donor: AIT Fellowship

Asian Institute of Technology

School of Engineering and Technology

Thailand

May 2018

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation and special gratitude to the chairperson of the committee, Dr. Mongkol Ekpanyapong, for his generous guidance, attentive support and encouragement during the period of whole thesis.

I also like to extend my gratitude and my sincere thanks to Dr. A.M. Harsha S. Abeykoon and Assoc. Prof. Erik L.J. Bohez for their kind support, guidance and willingness to serve as the examination committee members.

Furthermore, I would like to thank my parents and friends who extended their great support during data collection.

Finally, Thanks for each and every one who support me in various way to convert my thesis to successful thesis.

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. 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 problem. To achieve this all products in the mall should be equipped with RFID tags and all trolleys should be equipped with a RFID reader and LCD screen .When one puts any product in the trolley its code will be detected automatically , the item name and cost will be displayed on the LCD, 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 central billing unit via zigbee module . Hence the billing can be done in the trolley itself thereby saving a lot of time to the customers.

Keywords: RFID tag, LCD, RFID reader, Barcode reader, Trolley, Zigbee, Central billing unit.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

RFID	Radio Frequency Identification
UPC	Universal Product Code
LCD	Liquid Crystal Display
EEPROM	Electrically Erasable Programmable Read Only Memory
EPC	Electronic Product Code
LED	Light Emitting Diode
SPI	Serial Peripheral Interface
GUI	Graphical User Interface
GPIO	General purpose Input/Output
USB	Universal Serial Bus
IFF	Identification Friend or Foe
SDK	Small Development Kit
HDPE	High Density Polyethylene
LDPE	Low Density Polyethylene

CHAPTER 1
INTRODUCTION

1.1 Background

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 every day 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.

As indicated by a study directed by US Department agency , on a normal, people spend through 1.4 hours consistently on shopping. A considerable number of clients will tend to leave a line if the line is too long. The present Shopping environment can be essentially be characterized into two classifications

(1) Shopping in-individual

(2) Shopping in absentia.

Shopping in absentia is upheld from various perspectives including web shopping, online shopping, and so forth which will not require the buyer to be manually held at the Counters. Purchasing in-individual includes an individual call at location of purchasing and choosing items in view of different variables including need, comfort, brand, and so on. The proposed keen Shopping basket framework plans to help shopping in-individual that will minimize the time spent in shopping. Persistent change is required in the customary time spent at the counters to enhance the nature of shopping background to the clients. To beat these issues expressed above and to enhance the current framework, we have composed a Shopping basket. This can be done possible by basically connecting RFID labels to the items and reader with a LCD in the purchasing cart. From this framework client can posses data related to cost of each thing which are inside cart and furthermore absolute cost of the thing about the item.This framework will save time of clients and labor required in shopping center with respect to cost of the item .

Figure 1.1 illustrates the Shopping Environment in the modern World and and waste of unnecessary time at the billing counters.

Figure 1.1 Current Shopping Environment

1.2 Purpose of the 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 cart 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 .

1.3 Problem Statement

In realistic, markets are these days utilized by a considerable amount of individuals in order for securing most of items. Item procurement speaks to an unpredictable procedure that involves time spent in passageways, item area and checkout lines. Consumers commonly encounter some problems and difficulty during purchasing. These problems comprise worrying about the money which they have brought would be insufficient for all the items purchased and also dissipating a lot of time at the cashier[1]. And also it is becoming a increasing problem for the merchants to make their shoppers consigned and to anticipate

their demands because of the effect of contention and also because of lack of of equipment that isolate application designs. At some instances clients have issues with respect to the inadequate data about the item of discounts and thereby misuse of superfluous time at the counters. We can end this issue by supplanting the omnipresent Universal Product Code (UPC) standardized identification by keen names known as radio frequency identification (RFID) tag. To overcome the above problems, we implement the extensive notion of RFID based keen shopping cart in the field of retail stock[2].

1.4 Objective

The main objective involved in this plan is to implement a smart shopping cart with the help of RFID technology for improvising purchasing . The plan is to employ the RFID related surveillance implementation practice in the purchasing cart. In this plan RFID card is utilised as protection entry for acquiring of commodities in the Shopping malls. If the commodity has been placed in the shopping cart the price of the product appears and accordingly the total amount will be shown and 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 .In this , the technology used is for obtaining the products thereby which boosts security performance and speed while purchasing in shopping complexes. The technological objective for our presented problem in shopping complexes is the practice of RFID technology for the instinctive recognition of commodity in the interior of the purchasing cart thereby annihilating shopper intervening in the task of commodity purchase and for payment. The principle point of proposed framework is to give an innovation which is minimal effort oriented , effectively adaptable, and efficiently feasible for helping shopping in individual. With the help of this a lot of time will be saved at the billing counters .
Figure 1.2 shows the typical smart shopping cart which has LCD display attached to it.

.

.

Figure 1.2 Smart Shopping Cart

1.5 Future scope and limitations

In spite of the fact that the RFID can't totally supplant the standardized identification innovation because of higher cost precision and speed is high in RFID implementation. The retailers, makers and purchaser products organizations like CVS, Tesco, Prada, Benetton, Wal-Shop and Procter and Bet are presently actualizing the innovation and investigating the effect of the innovation on their business. Others can likewise implement RFID. The basis of accomplishment lies in understanding the innovation and different components to minimize

the potential issues. It is time for the Industry ought to begin using the new innovation, for example, RFID in different applications, for example, fabricating, and storing purposes. In this project the items in the cart is restricted to less than 50 as the customers don't prefer excess luggage at once. Tags used here can be attached to the products only in the longitudinal fashion without any folds .Tags given for the reader are of length 8cm and of width 2cm and they need to be attached to the products in a visible fashion for the reader then only the reader can detect tags with out any fail. Tags used in this project are water sensitive and metal sensitive and have the capacity of reading only one side. So the trolley is now restricted to use water sensitive packaged and metal sensitive packaged products. But the problem can be rectified with the waterproof tags and metal resistant tags which are under research at present. And the multiple object RFID reader used here has the constraint of skipping the tags at sometimes. Reader which can detect less than 50tags/sec is employed according to the requirement and meanwhile cost will also be under control for implementation of system.

1.6 Structure of thesis

The outline of this thesis is shown as follows.

In Chapter 2, Information on RFID technology, object detection methods and literature review of some of previous related studies are provided .

In Chapter 3, the methodology of the proposed system will be provided.

In Chapter 4, the implementation and results will be provided.

In Chapter 5, the conclusion and recommendation will be provided.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

RFID is an up coming innovation which has as of late pulled in light of a legitimate concern for the exploration group in view of the uncommon advantages it offers over the other existing recognizable proof and information detecting advancements. RFID is a specific term utilized for systems which use radio wave to naturally distinguish things. RFID is a technology that permit exchange of information amongst labels and reader without the need of viewable pathway over a separation up to a couple of 10 meters relying upon the sort of label engaged. For this framework the information is being swapped by radio waves and distinct tags can be scrutinized or collected normally . This part is designed to survey the current technology writing and probe the problems in the existing RFID organisation starting from the transformation to yet in its recognition phase. From past the growth of this revolution from 1900's, aside to this expressed reliable perspectives, thus innovation likewise supports a few affairs or points. A planned motivation behind part for look at the writing identified with the above mentioned technology additionally develops scholarly analysis with giving an deal into a segment of the outstanding and noteworthy cases hindering the growth of this alteration. It ought to confront these cases with a specific end goal to give a more prominent perceivability and an enhanced item speed of the RFID innovation.

From past 1900's, the evolution of this innovation aside the expressed affirmative viewpoints, the innovation additionally carries a few problems. And the anticipated rationale for part is to have a look at the writing related to Radio frequency Identification further develops scholastic research, and giving a knowledge into a portion of the exceptional and urgent issues blocking the development of the RFID innovation. There is a emergency need to address these issues with a specific end goal to give a more prominent perceivability and an enhanced item speed of the RFID innovation. The main utilization of radio waves to transmit signals goes back to Worldwar II when transponder (labels) were put on plane and used to recognize drawing a nearer plane . Interrogators dispatched a signal to the system on the plane and the signal delivered previously could be deployed to identify amicable and hostile flying machine.

The historical backdrop of RFID innovation advancement is shown in Tabel 2.1

Tabel 2.1 History of RFID Development

Decade	Event
1940- 1950	1. RFID was used in major Second World War advancement exertion. RFID designed in 1948.
1950-1960	2. Premature investigations of innovation began.
1960-1970	3. Improvement of hypothesis, initiation

	of field trials started.
1970-1980	4. Blast of Development. Experiments has accelerated.Advance executions has begun.
1980-1990	5. Business uses of standard established.
1990-2000	6. Its usage increased and turns into a piece of ordinary life.

Differentiation between Prevailing and Suggested System

Tabel 2.2 shows the differences between existing system and suggested system.

Tabel 2.2 Comparison between prevailing system and suggested system

Prevailing System	Suggested System
1. Hand operated Invoices.	1.Instinctive Invoices
2. Uses Barcode for Billing	2.Uses RFID tags for Billing
3. Human staff is needed for Billing Purpose.	3.No human staff is needed for Billing Purpose.
4. Difficult to track the product.	4.Simple to find or trace commodity.
5. Getting product information is difficult and time consuming.	5. Collecting commodity data is easy and additional time not required.
6. It doesnot expose an involuntary way of implying to the shopper the way in which aggregate bill is impacted as commodities keep on adding and removing from the cart.	6. LCD will show the improvised bill at each instance the shopper increase or reduce commodity from the cart.
7. Only one single product identification at a time.	7.Allows Multiple product identification at a time.

Currently , the practice of barcode for commodity recognition demonstrates various restrictions: data is steady ; allows only one scan at once ; involves vicinity ; less extent and low surveillance. This technology is further immune, secure, recognizes items in a specific order, and also facilitate distinct kinds of data, various synchronous scans, will not require vicinity and it has a large scope. So that instinctive item recognition is attainable if and only if all prevailing items within the mall are recognised with tags and every trolley with a scanner. The usage of this technology as a result include many advantages like enhanced security , subsequent decrease in misplacement of products, decreased person interference and inaccuracy, extended rapidity in assigned operations, remarkable recognition of items with auxiliary details and obtainability of realistic particulars when compared to other automatic identification systems.

2.2 Automatic Identification Systems

There are several technologies available for Instinctive Recognition systems. In words of implementation, price necessity and the method associated single or a blend of results are selected for Instinctive Recognition effectiveness.

Barcode Systems

This implementations contain a double code comprising of exhibit of bars and spaces organised in parallel design as depicted in figure below. The sequence is of broad with limited bars and spaces which are depicted numerically and alpha numerically. This is done by optical laser scanning. Inspite of same in their material implementation there are much more contrast among the code designs.
In Figure 2.1 a typical barcode which is printed on products is shown as follows.

Figure 2.1 A typical Barcode system

Optical Signal Identification

This was started in the past 1960's. For this specially designed fonts were developed which styled the signs so that they are studied easily in the usual mode by the people and instinctively through the equipment. The main utilization associated with this technology is huge solidity of data and the feasibility of interpreting data graphically during emergencies. This technology was applied in the banks for the registration of checks, productive and administrative fields. Inspite of many advantages also this technology vanished globally due to huge costs along with complexity when compared to other identification systems.

Biometric Procedure

Biometrics is the science of computing and having magnitude methods involving human beings. It makes use of approaches to differentiate living beings by error free and unique physical characteristics. In implementation they include thumb marking, palm marking methods , vocalized recognition and opticdisk recognition.

Smart Card

Smart card is an automated information application probably with extra calculating magnitude which is blended into a plastic card as shown in the figure. These cards are furnished by energy and timer beat from the machine through the touching exterior . Information shift between the machine and the card takes place through a two guiding sequential connector. One of the primary benefits associated with the smartcard is that the information saved in it can be defended in opposition to not suitable approach and exploitation. The disadvantage mainly involved with the contact based smartcard is the susceptibility to corrosion ,dirt . Also the reader machines that are used often are also expensive to sustain because their accountability to fade.

In Figure 2.2 a typical smart card is shown as follows.

Figure 2.2 A typical Smart card

RFID systems

In RFID systems information is stored on an automatic information transfer equipment. This is more or less similar to Smartcard. Although the electrical discharge to the information transfer device and the statistics swap are attained with no use of touch like in smartcards but by using magnetic or electromagnetic scopes. A model of RFID system is presented in the figure beneath .Because of the numerous benefits of this when compared to alternate recognition systems these are going to get enacted all around.

Figure 2.3 shows the typical RFID system.

Figure 2.3 A typical RFID system

Comparison between Barcode and RFID

Tabel 2.3 shows the comparison between Barcode(existing) and RFID(proposed) technologies.

Tabel 2.3 Comparison between Barcode and RFID

Barcode (Prevailing Technology)	RFID (Suggested Technology)
1. An individual is needed to study the barcode upon the commodity.	1. Involuntary perusal of RFID tag from the commodity.
2. Barcode must be perceptible on the exterior of the commodity .	2. RFID is placed in the interior of the commodity.
3. Line of vision is necessary to study a Barcode.	3. No line of vision is entailed for this.
4. The legibility of ciphers can be damaged by flith, humidity and decay and during wrapping.	4. This is not influenced by the similar conditions.
5. The accessibility range is up to few inches.	5. The accessibility range is up to few meters.
6. Barcode does not have read and write capability.	6. RFID tag having read and write capability.
7. The damaged tags won't work properly.	7. The damaged tags will work flawlessly.
8. The content updating can't be done .	8. The content updating can be done.

2.3 Analysis of RFID from printed reviews

In 2009, the College of Arkansas Data Innovation Research Establishment done a study which reveals the advantages of tagging products with RFID tags for routine operations and also for business value at any prime retail store. The outcomes exhibited that general stock exactness enhanced by extra of 27 percent, under stocks reduced to 21 percent, and overloads reduced to 6 percent. It likewise also contrasted to what extent it brought with total things utilizing RFID versus a scanner tag reader. With RFID, inspecting 10,000 objects has taken two hours; while a conventional reader has taken 53 hours .

Almost 15 billion sets of footwear and 10 billion design attire things get transfer from makers consistently. Therefore prices of leading physical stock of this things, overseeing unavailable stocks, also anticipating robbery keep on rising. Clothing retailers are quickly receiving commodity level observance to empower exact perceivability of every piece of clothing. Unending stocks are moving at rate of 60-70 percent progressively. Forte attire merchants those outline, origin, along with offer items supporting their personal particular labels are acknowledging critical outcomes, for example, a 14 percent deals raise and a 90 percent minimising in the moment involved to lead week after week stock.

A creative item with societal acknowledgment is the one which escorts solace, ease and yield in regular existence. A novel item has been created to help a man in ordinary shopping as far as lessened time spent while buying an item at the best cost accessible[3]. Open familiarity with this technology was uplifted as of late when merchant monster Wal-Bazaar wanted their sponsors to employ this innovation. In 2005 January Wal-Shop's CIO expressed about utilizing this innovation come about as a part of 26 percent decrease in deficit stocks in the shops with this technology utilization, and shortage of things which will be renewed thrice speedier than the things which are not RFID marked .

Bill McBeath in April 2013 uttered merchants to make it devise in shops so that it will be simple for buyers to purchase at anyplace, get at anyplace, and to give back at anyplace.
An ease wise shopping that helps the client to look and select items and illustrate the client on any extraordinary offers accessible on the products as they walk through out in the Purchasing malls[4]. A framework that can examine fixed items in the purchasing space deploying the technology[5]. A framework was build to help a man in regular shopping regarding lessened time spent while buying[6]. A shopping basket was build with an Item Distinguishing Gadget that consists of a microcontroller, a LCD, a RFID reader , EEPROM, and ZigBee module. Acquiring item data will be done through a RFID reader on shopping basket, in the interim item data will be put away into EEPROM connected to it and this information will be send to central billing unit through ZigBee module. The central billing unit gets the cart data and EEPROM information and computes the aggregate sum of buying for those specific cart[7].

RFID has enhanced deficit stock precision in stores drastically, by 20%-30%. JC Penney enhanced deficit stock exactness from 75% to 99% in classes utilizing the innovation. The execution of a system involving RFID allows the customer a new experience for Shopping. At the point when getting into the store, purchaser leads towards a shopping basket that has a mechanical framework on the steering bar that consists of a hand tap display , a customer programmed card and an item reader[8].

2.4 Analysis in RFID

In a paper, Alexander has revealed how accessible ID and RFID strengthen effectiveness in building systems, changing the gain of an organisation and significantly building quality of consumer supervision. This advancement reviewed strengthening safety against robbery, lowering loss and smooth running of aligning strategy. Marking at the device proportion are unique favourable circumstances in products getting, inventory and payment in realistic cash becomes faster and further effective thereby additional benefits are made , for instance, customer administration. A significant point can be solved by this innovation is that items which are out of supply , products not seeked at moment as of misty when and

where amount of were in deficit supply with case of update .Thus by employing of this advancement in 21 different associations in diverse businesses, it was presumed that there will be four basic benefits of transformation by adapting this technology : decrease in the amount of work , less intervals of time spent , less supervision and low degree of failures.

In a review, Roh says that he trusts that there are three elements which effect when associations opt to accomplish this technology ; the foremost is interest from consumers , suppliers , the second is the benefits expected from the RFID into usage, price grants by low robbery, short requisite for effort and hardware prices, and a directpath in the inventory chain and the final component is that modern firms types . It covers how the development of RFID tags creation is advancing repeatedly ,becoming much lower in size , the enhanced instruction restriction and decrement in prices.

2.5 Advancement in Sweden

The utilization of RFID in Sweden is broad in numerous applications and enterprises. It utilized for instance as a part of libraries, and burglary anticipation and to all the more effortlessly to discover books and sort them, additionally for clients to acquire and return books all alone. There is likewise an expanded effectiveness component in that you can obtain an entire group of books in one time . Cattles that must be named can have a RFID tag in the ear that streamlines the authoritative work, permitting the checking of creature development and permits supervision of the animals from beginning up to the end customer . Home related administrations use RFID in order to have the capacity to open the entryway in case if the person is in a position not able to open. Just to utilize RFID innovation to open the entryways is something that is turning out to be progressively normal in houses, workplaces and pantries .

2.6 Technology in Stock Network

It demonstrates that accuracy which specifies that significant appropriate level of RFID is attained in the whole production chain , of course there are accurate benefits to the shoppers, for example , mishaps are diminished by 66% by usage of this framework. It depends on upon the problem foregoing in the store matrix, deferred transportation and establishment flaw.

If we glance at the difficulties, this technology might assist both the trader and consumers. It will give tremendous benefits such as less time spent in getting items , arranging and the deficit stock loss can also incredibly decrease. Consumers can easily purchase commodities incase if they are misplaced in the shop, they can be efficiently found by usage of this technology . Further reviews on the technology effecting consumers are made calls for notice that this innovation is a hazard to safety and to successfully achieve this innovation in purchasing products, an association requires to exhibit the right position.

It illustrates that the connection with this technology is examined to have two beneficial characteristics,the foremost one is perceptibility indicating finer outview of the warehouse original stock and in this way accurate demand can be predicted . The second is that the additional info regarding the shop supply ,disasters and theft is decreased.

The utilization of this technology in stores will be as where the consumer entrance ID contains a label and the prices of commodities are updated depending on the consumer

previous purchasing act, and in view of discounts, sales, and so forth . It stresses on the theraphy of drug which will get increased if there is a transition from scanner labels to this advancement achieved. Accompanied by the accessible supply constantly , problems will be diminished strongly, inducing technology in supply which would minimise demanding prices . Mentioning the problems which should be viewed as the obstruction amidst RFID execution must to be disappeared when large number of people start using this technology with the motive that norms are fixed and overheads get decreased. Different essays are made regarding supply and how technology will have impact on it. Large number of shops supply volume which is not good on the grounds that if the allowance from the sales of merchandise occurs at the mislocating which deals with the difficulty . It also oversees at the impact of the robbery which has been on misplaced supply levels and how it can lessen the amount of flaws.

2.7 RFID Usage Challenges

Effective RFID usage system requires some serious energy and effort. An undeniable framework execution in a vast assembling organization can cost $10 to $25 million. This advancement handles different implementation tests. The real problems involve alteration in growth, global embedding , management controls and price .

A framework will be set in all the trolleys and this consists of a RFID reader. Each item in the shopping center should be provided with RFID labels. The moment the consumer places the objects in the cart , the corresponding cipher is identified and also the cost of the respective commodities are saved in the storage unit. Likewise by go on placing the items , the prices are computed and gets added to whole amount. Like this way the computing takes place in the cart itself. Commodity particulars are exhibited on the LCD. In the same way the commodity label and the price will be reported through earphones. Near the payment centre the whole invoice info is switched to Personal Computer via secret Radio frequency units[9].It also additionally talked about the improvement of showcasing implementations .

Tabel 2.4 shows the comparison of various automatic identification systems in terms of different parameters.

Tabel 2.4 Comparison of Auto-ID systems

Parameters	Barcode	OCR	Biometric	Smart Card	RFID
Typical. Data Capacity	1~100	1~100		16~64k	16~64k
Data density	Low	Low	High	Very high	Very high
Readability by people	Limited	Simple	Difficult	Impossible	Impossible
Reading speed	Low	Low	Very low	Low	Fast
Reading distance	0~50cm	< 1 cm	0~2m*	Contact	0~30m
Cost of readers	Very low	Medium	Very high	Low	Medium
Unauthorized copying / modification	slight	slight	Impossible **	Difficult	Difficult
Influence Factors					
Dirt / damp	Very high	Very high	--	Possible	No influence
Covering	Totally fail	Totally fail	Possible	--	Very low
Direction and position	Low	Low	--	Unidirectional	Very low

2.8 Investigation and writing review

One of the RFID's fascinating feature is it's major characteristic of not requiring line-of sight when reading RFID tags. RFID scanners can respond to labels in milliseconds and can check various things at the same time. It guarantees to computerize the billing to extraordinary levels, prompting work decrease all through the counters. The dependability of RFID tags is an issue that could represent the moment of truth their across the board achievement. RFID labels can be read at much more prominent separation, readers can pull data from a tag at separation up to 300 feet, they can read RFID labels much speedier, can read rates of forty or more labels for each second .

The foremost batch of laser scanners in the 1970-80's used (comparatively huge [632.8 nm (red)] TEM-00) Helium-Neon laser tubes and then later developed to solid state semiconductor lasers as they used to discharge light which is detectable and also because of large decrement in their prices comparatively(below $100). This Contactless electronic laser scanners are considered to be mobile devices for upcoming generation. This can be placed in either mobile handhelds or large stationary elements. This process consists of a persistently moving beam scan components (eg., rotating polygons, oscillating mirrors, holograms) which are responsible for automatic scan rate of minimum 40 scans per second. The analog signal received by the photodiode is filtered, amplified and converted into a digital signal which is then evaluated by the decoder[10].

RFID labels can be called as composed gadgets; the RFID reader can speak with the tag and can adjust as a great part of the data as the label outline permit and additionally have the advantage of reusability of tags . With the expanding pervasiveness and moderateness of RFID labels in ordinary verification framework, RFID hold awesome guarantee in the retail world for both clients and stores in stock control, comfort, and cost investment funds. Our implementation used these RFID tags to mechanize the checkout procedure by building a framework that could read the RFID labels of the considerable number of articles that would be put in nearness to a receivable stage. This disposed of the requirement for scanner tag filtering of every individual thing, making checkout a fundamentally speedier experience. The labels are little in size and consequently can be glued on items.

RFID is a programmed identification and information oriented innovation which is made out of three components: a tag shaped by a chip associated with a receiving wire; a reader that radiates radio flags and gets consequently replies from labels, and finally a middleware that extends RFID equipment and undertaking applications . As per EPC-Worldwide norms, the chip memory contains an Electronic Product Code (EPC) which permits the identification of every item particularly . There are different EPC designs; 64 bits, 96 bits or 128 bits. EPC of 96 bits can distinguish more than 268 million producers, more than 16 million sorts of items and right around 69 billion articles for every maker . Through radio waves, RFID advancements give a continuous correspondence with various articles in the meantime at a separation, without contact or direct viewable pathway. These propelled identification and correspondence qualities of RFID can enhance the item traceability and the perceivability among supply chains. For instance, RFID innovations can build precision, efficiency and rate of procedures. It can likewise diminish capacity, taking care of and circulation costs and enhance deals by diminishing the quantity of stockouts . The commitment of RFID to supply

chains is in expanding the efficiency as well as in supporting the rearrangements that turn out to be more productive.

After the arrangement of RFID innovations, Procter and Bet and Wal-Store at the same time decreased stockout levels by 70%, enhanced administration levels from 96% to 99%.They additionally lessened organization costs by re-building their supply chains. RFID innovations have picked up significant enthusiasm from inventory network ventures and scholastics as of late.

As indicated , the first applications set apart amid the Second World War were made to differentiate cordial planes from adversary planes (IFF Framework, Identification Friend or Foe) . RFID advancements have made progress through the late enhancements in information handling and microelectronics. The parts of this innovation are getting to be littler and littler, not so much costly but rather more effective . Accordingly, utilizations of RFID in store network have expanded. The expectation of RFID development as from $1 billion in 2003 to $4 billion in 2008 to $20 billion in 2013.Current uses of RFID spotlight on stock administration, logistics and transportation, collecting and fabricating, resource supportance and protest area, and so on . A few parts have more chance to pick up from the different RFID applications, for example, retail, medicinal services, material, car and great enterprises.

The Central Automated Billing System which reads the commodity information and computes the aggregate sum of shopping for particular cart[11]. Since every cart is equipped with RFID Reader and by ZigBee correspondence total amount gets delivered to central system , where it figures total price for the received commodities. Customers receive their total invoice at the Counter area as indicated by their Cart Identification number. Although there is no need for a person at the counter , if consumer utilises their debit/credit for invoice payment. The automatic billing system comprises of a ZigBee transceiver and a system connected in carts to get product details including price, quantity and so forth[12].

2.9 US Basic supply industry

Clients can undoubtedly spend 5 or 10 minutes meandering around the store searching for a thing, all the more so in a major store. Obtaining products can likewise take a lot of time. It has been assessed that from things considered consumers spend through 10 minutes holding up in line and looking at, and could without much of a stretch spend through 25 minutes if the line-up is long. As of late a lot of duration and strain has been spent on creating frameworks for diminishing client buy duration and to obtain high customer loyalty. To account numerous investigations along with developments taking place every time in merchant industry along the utilization of RFID, WiFi exchange, Standardized identification, compassionate , internet purchasing , portable implementations and so on. "QB"- (Quick Buy) is produced in order to lessen customer buy duration along with great devotion with clever purchasing basket concerning merchandise. Thus this practice provides an improved way for purchasing to the consumers with effective procedure[13].

Amongst are fairly rare ventures ready in connection to invoice mechanization, interior portraying along with exploring from colleges and different associations around the world. In South Asian nations there is no framework being used for purchasing products .It analysed a

few of the instinctive recognition technologies which comprise imprinted ID codes, 1D/2D bar codes, RFID, magnetic stripe and smart card to mark several commodities.

Shopping for food is among the most widely recognized exercises of the grown-up populace. Cherish it or scorn it, we are regularly at the grocery store. As indicated by the specific Institute, exactly 32 million American grown-ups shop at a supermarket on any given day, one out of each seven grown-ups across the country**.** It's imperative for markets and general stores to concentrate on creating amazing client encounters today said by Brian Jones, VP of Grocery and Customer Packaged Goods at Empathica. In addition , more than 20 % clients will desert their buys or surrender absolutely from getting required administrations and leave the store when confronted with long lines that seem stagnant. This can be overcomed by developing a system which can assist shoppers in their daily routine of purchasing products by reducing their time spent at the billing counters [15].

2.10 The Advancement of RFID

RFID is a developing innovation that has been around since mid 1900's and was utilized as a part of World War II . A preliminary analysis had inspected work based on innovation which expressed that Obviously, significant innovative work must be done before the field of valuable applications . At that point, the electromagnetic hypothesis identified with RFID had already been read in 1960's . Apart from them ,it notifies about the Newly initiated radio frequency identification devices occurred in that time. At this point, the RFID growth had begun twisting. 1960's had been the begin of the revolution in business exercises. A perceptible change of service around there had happened in 1970's . By 1980's, innovation had come to fruitful . The organizations which started utilizing this innovation was seen as a part of 1990's . The stride of improvements is too clear in the 21st century enhancing the fitting of RFID labels to that of different products.

2.11 Innovation improvement

At first look, it creates the impression that the innovation is retaining its significance with no trouble because it might be a basic innovation, but however in fact it will have its cons. This is an innovation that ranges crosswise over assorted zones like CMOS outline, information administration, encryption, radio spread, sensor configuration and combination, system designing . RFID innovation makes utilization of segments like labels and readers (ordinarily associated with a host PC or system). The RFID labels are assembled utilizing silicon chips and radio waves.

In light of being classified as dynamic or detached, RFID labels are controlled by a storage cell or will initiate up by the radio signals radiated through a specific reader separately . The data accumulated by a RFID investigative specialist from a RFID tag is put away utilizing a database framework . A capacitor situated in the circuit of the Radio tag is charged by the energy discharged from the reader and therefore is utilized to transmit the tag information to the reader **.** Choice amid dynamic along with detached labels deployed is a urgent segment of a compositional plan procedure. Engineering outline of the RFID system is entirely fundamental with regards to improvement of a RFID framework. Regardless of the sorts of segments utilized as a part of a RFID framework, the RFID framework execution is assessed in view of the way effectively tracing items . Even the RFID tags which can withstand high temperature and are resistant to liquids and metals are also being developed[16].

It is pivotal to create system that can scale in size . It was reasoned that with RFID flawlessly rising as the new inventory network standard, the open door is gigantic in this business sector. It demonstrated that If a trading is going to triumph of labels , all should initially see in such a way that the innovation assisted their matters and should choose equipment and software in such a way to their trading which would be flexible for future development. Even the expiry date of the products can also be included with the products information like quantity, price etc[17].

2.12 Misuse of range

For RFID applications, the accessible range of frequencies is entirely restricted. In addition, it is dealt with or rather assigned by various national and in addition territorial administrative powers. Furnished with this constrained transmission capacity and the differences of working periods , the respective conventions between the readers along with labels need to use the accessible range effectively . With time, as more RFID frameworks are actualized, the accessible data transmission gets to be over-used and impacts amongst readers and between labels get increased, bringing about performance to a low grade. In order to consign that type of affairs , investigation is continuous in the regions of label hostile to crash conventions .Concurrent communication in RFID frameworks head to crashes as the readers along with labels work on the common remote passage . In this manner, impact assertion for RFID labels is a noteworthy issue for quick identification. The crash issue happens in signal transmission from reader to labels or viceversa which hardly induces identification. Subsequently it turns into a key issue to build up a excellency against impact convention in order to minimize crashes in this zone .

The crash issues might be outlined into label impact issues and the reader impact issues . In genuine useful RFID frameworks, the previous happen more frequently than the later. The label impact issues are further sub-separated into dynamic label crashes and more confused distant label impacts. Since, the low-utilised detached labels can't distinguish impacts or make sense of neighboring labels, it is of incredible criticality to build up a label against crash convention enhancing the ID capacity of RFID frameworks.

2.13 Information stock piling and administration

By giving the capacity of programmed ID, the RFID innovation can be utilized to fundamentally enhance the proficiency of business procedures. This area of the proposition concentrates on the qualities of RFID information and the difficulties postured by RFID information. Through the programmed information gathering given by the innovation, it can accomplish more prominent perceivability and item speed over supply chains, more effective information administration, less human interference, lessened item duplicating[19]. RFID postures numerous information related difficulties along with amongst the greatest slopes to manage surge of information it creates .

Additional many things opposing the elite of innovation is due to the incorrectness of the information streams produced by readers. In true RFID organizations, rate of readers scanning labels is regularly in the scope of 60-70% . The read information involves the right information and also the messy information. This messy information shows up as inconsistent readings, missed readings and information excess. Getting the messy information is exceptionally regular in technology applications along with continuous merits in circumstances of ease, less electrical discharge equipment along with remote interchanges .

Thus, there is a requesting need to address surrounding components influencing the precision of RFID information prompting enhanced exactness of a RFID tag.

2.14 Applications and client appropriation

A remarkable section of the literature promotes the advantage and price reduction that the firms procure through executing RFID, from perceptibility through supply chains and quicker scrutinizing of inward commodity.

Figure 2.4 depicts to a pictorial view of the RFID technology which is received all over the planet which has been taken from the data examining review in particular Clothing RFID, (IDTechEx, 2009-2019) .

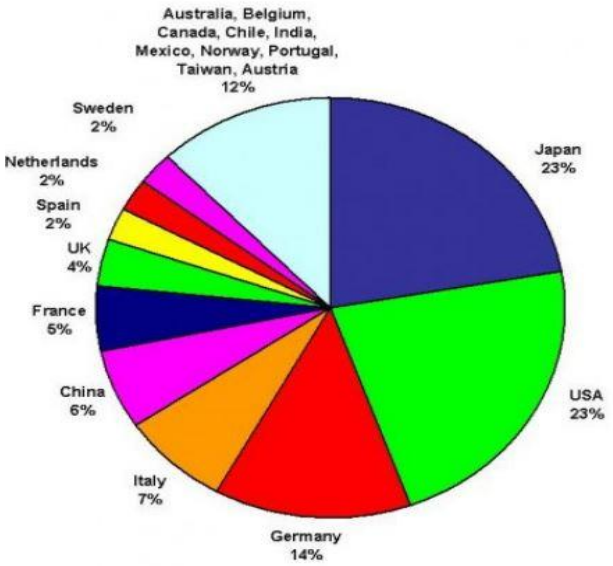

Figure 2.4 Adoption of RFID Technology across the world

It elucidates different organisations in whole directing the planet and are presently using this technology as depicted in percentages. It furtherly mentions that the advantages are intense and colossal from enhancing client administration and productivity - including diminishing stock outs - to lessening falsifying, robbery and scattering and robotizing sorting procedures and stock takes.

As per the most recent 2009-2019 RFID TechEx statistical surveying review , An expansive number of real brands are working together to make the procedure consistent, from tiny assembling to large deal in the store and even later use for overseeing client returns and other activity like the checkout. The selection in this business sector must be done on by customer request.
Purpose for this is clear as including in any effective RFID application need to remember the client's perspective. It also portrays the possible enterprises for RFID and comprising amid divided price and seclusion. Further an practical analysis on the client conception about technology is explained . Scope for many more features like reading products name and cost and storing data for further purchasing can be included in future days [20]. Suggestions can also be given to the customers based on their shopping history[21].

2.15 Research gaps

The innovative improvement parts of technology indicated atop despite the fact which would demonstrate that the innovation has progressed significantly yet at the same time it needs to vitally concentrate on resuscitating the structural configuration of a RFID technology that can scale in size as per the evolving needs.

Broad measure of work has been done in the current writing on RFID anticollision conventions to enhance the execution of RFID frameworks, yet not very many observational examinations have been made in the same connection with a specific end goal to evaluate the advantages of the Cipher Isolation .

Despite the fact , a large amount of considerable quantity of work has been done by identifying with the performance of RFID frameworks .There will be some compelling issue to address this vital execution concern of frameworks. In the writing, regardless of much research being done on the information administration viewpoint in RFID frameworks, the concern of fault indications or taking care of vulnerability in RFID information is not tended to from the perspective to include this present reality instabilities connected with the RFID information but these may assist help keeping in mind the end goal to reach all the more semantically ultimate goals for more prominent purposes.

Also, from the primary passage of this writing , it is entirely clear that bulk and rapidity of information will transcend the limit of prevailing innovation base. Thus, there is no need to offer a design that is not fit for overseeing advanced RFID information but rather additionally can oblige the arrangements of existing RFID issues thinking about genuine vulnerabilities. Also, in that is a enthralling urge to convey this concern in to the brilliance and to strive for gathering of the development at a more broad magnitude.

Further it concentrates on the innovation being developed all over the world for a various arrangement of uses. Likewise on the identical hand , it shows the interest of customers which might comprise the buyer of the innovation for its advancement along with ample extensive utilization. Likewise usage expenses also need to be considered along with frameworks, it requires an interest to spare that danger before genuine performance of the composed framework.

2.16 Nation specific mannerisms

For RFID applications some range groups are not for business use in Japan and parts of Europe. For example the frequency band at around 900MHZ is as of now assigned for the versatile correspondence at some countries.The circumstance opposes the interoperability of RFID labels and readers among nations around the world. For the application over the borders,the nation particular requirement restrains the RFID selection for business use. Later on through the Standard Association's order and the backing by governments, the frequency distribution issue could be continuously highlighted for the far reaching arrangement in Enterprises**.**

2.17 Value Execution concern

As we probably aware right now in investigation with standardized identification marks, RFID labels are still a great deal of highcost . The unit cost for standardized tags is just

couple of pennies and it can even be printed specifically to the item bundles or boxes. The RFID labels will cost 60~80 pennies now. For dynamic RFID labels, the expense could achieve couple of thousand USD dollars. There is a major value between these two arrangements now. Despite the fact that RFID has advantages when compared to the scanner tag , label expense is the real scenario when comes toward the business selection. In the mean time, the framework implantation cost incorporates the equipment and programming are a major costs for the organizations.

As far as business applications, the basic attentiveness toward the implementation are the label cost as well as its exhibitions it can reach. For example the RFID labels utilized as a part of social interest are those which can diminish the destructive mistakes by human operation. The disappointment costs because of these sorts of mistakes could cost a huge number of USD Dollars .Through the RFID implementation , the danger for these mistakes can be lessened by accurately checking the data stream .

2.18 Summary

Tabel 2.5 shows the comparison of proposed system with the developed systems . The Journal 1, [8] describes a system which uses headset to announce products name and list. The Journal 2, [14] describes a system which uses audio indication to notify the certain limit for purchase of products and a led indication for respective product data received. The Journal 3, [18] describes a system which purchase history from a Centralised system to assist customers in shopping.

Tabel 2.5 Comparison of proposed system with respective to other Journals

Proposed System	**Journal 1 [8]**	**Journal 2 [14]**	**Journal 3 [18]**
1.In the proposed system we designed a special feature for cart in such a way which is surrounded by RF shielding to avoid detection of products outside the trolley.	In this system they have used additionally headset to announce products name and list.	In this they have used audio indication to notify the certain limit for purchase of products and a led indication for respective product data received.	In this ,they have used a system which shows purchase history from a Centralised system to assist customers in shopping.
2. In this Raspberry Pi is connected to the RFID Reader through USB for detecting products .	In this ARM processor is connected with RFID Reader,Barcode Reader,IR sensor and RF Module.	In this ,the microcontroller is connected to RFID Reader,Buzzer/Beeper and LED.	In this microcontroller is connected to Reader, EEPROM. There will be one more RFID Reader at the exit of the door for antitheft.
3. Zigbee module is used for transferring of information from Reader to Central Billing unit.	RF module which contain both RF transmitters and Receivers in a small electronic circuit are used for transmission	RF modules are used to transmit information for searching products from the trolley to the specific location of	Zigbee modules are used for transmitting of data from trolley to Billing unit.

	of data from trolley to the Billing unit.	the products .	
4 .In this ,there will be automatic add/removal of products from the trolley.	In this Rfid Reader is used for scanning normal products and barcode reader for scanning vegetables,oil etc and IR sensor for counting of products.	This system provides search mode for searching products by enabling with keypad and audio indication is to notify excess amount and a led indication for receiving products.	This system does only addition of products and EEPROM is used for storing products list.
5. In this 320x480 touch Screen LCD is used for display of all items list , their respective cost and total amount and besides to that it has options to make system user more friendly.	In this , 16x2 LCD displays products name and cost individually.	This system uses 16x2 LCD to display only product name, respective cost, of one product at a time.	In this system, 16x2 LCD displays product name, quantity and respective cost of each product at once.
6. Python is the language used by Raspberry Pi for connecting with RFID Reader .	Embedded c is used by the hardware that is connected to RFID receiver inside the trolley and VB is used on the front end to exhibit the final billed amount to the customer.	Only Embedded C is used by hardware which is connected to RFID receiver inside the cart.	C is the language used by hardware which is connected to RFID Reader.
7.The system accuracy is 80.9% and precision is 86%.	The system accuracy will be less when compared to propose because of delay in response from ARM since it is connected to many modules.	The system accuracy will not be good due to delay in search of products from trolley.	The system accuracy will be better when compared to first journal since it uses EEPROM and Zigbee.

CHAPTER 3
METHODOLOGY

3.1 System Overview

The proposed system in this thesis will be implemented into two parts . First part is the initialization of the Raspberry Pi for the set up of RFID Reader and Zigbee . Second part is the tag detection of products by RFID Reader which are placed in the cart and sending of product information from cart to Central billing unit through Zigbee.

The overview working of this system is - This proposed system works as on customer getting into the mall she/he first takes a trolley. Every cart is connected with a RFID reader ,a microcontroller and LCD screen. When the customer starts dropping products into the trolley, tags will be read by the reader and the reader sends the information to the microcontroller. The microcontroller compares the information with the data already stored in it. If the data matches then the cost of that product will be displayed on the LCD screen for user . If the user wish to remove any product from the cart then they can take away that product from trolley and cost of that particular product will be subtracted from the total amount instantaneously and after shopping the products data with total amount gets transmitted to the central billing system through zigbee. The RFID Reader will be placed in the mid position on the base/bottom inside the trolley. The cart is designed in such away that the outerpart of the trolley will be covered with RF(Radiofrequency) shielding in order to make sure that the RFID reader will not read any products associated with tags outside the cart.

Figure 3.1 shows the block diagram of proposed system in which reader is connected to Raspberry Pi which in turns gets connected to LCD and Zigbee which then sends billing information to Central Billing unit

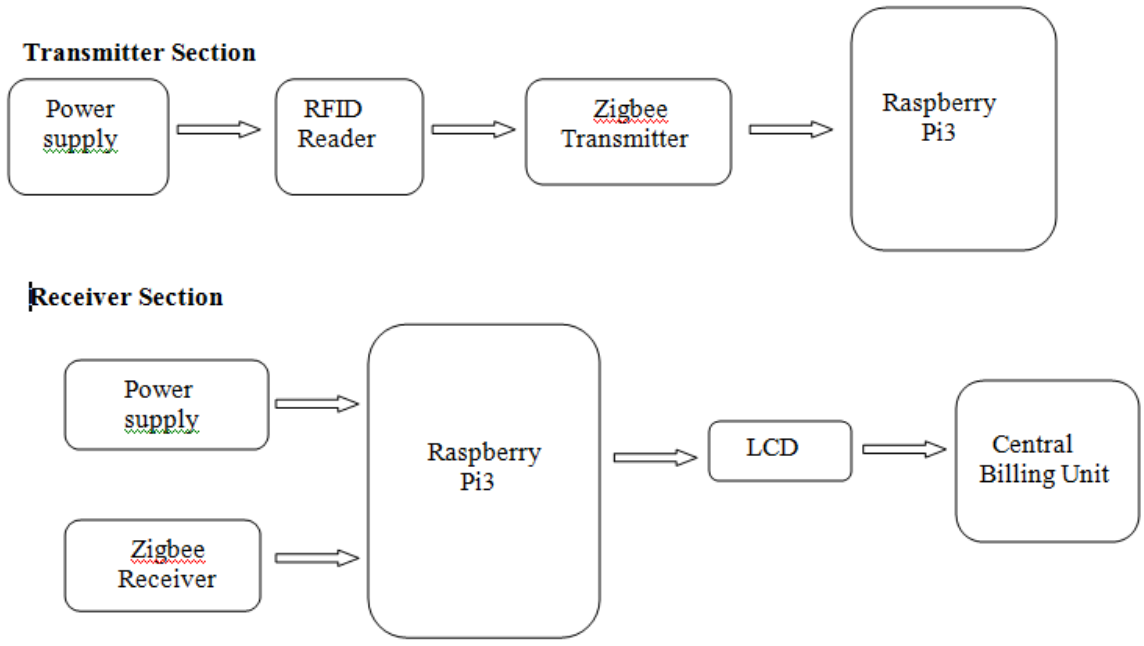

Figure 3.1 Block Diagram

At the transmitter section the reader detect the tags and sends the data to Raspberry Pi which then compares it with the data stored in it and displays on the LCD Screen attached to it.The zigbee transmitter sends the information displayed on LCD. Zigbee receiver present at the Central Billing unit finally prints the data sent by the Zigbee transmitter.

3.2 Schematic Design

Figure 3.2 shows the wiring of the proposed system.

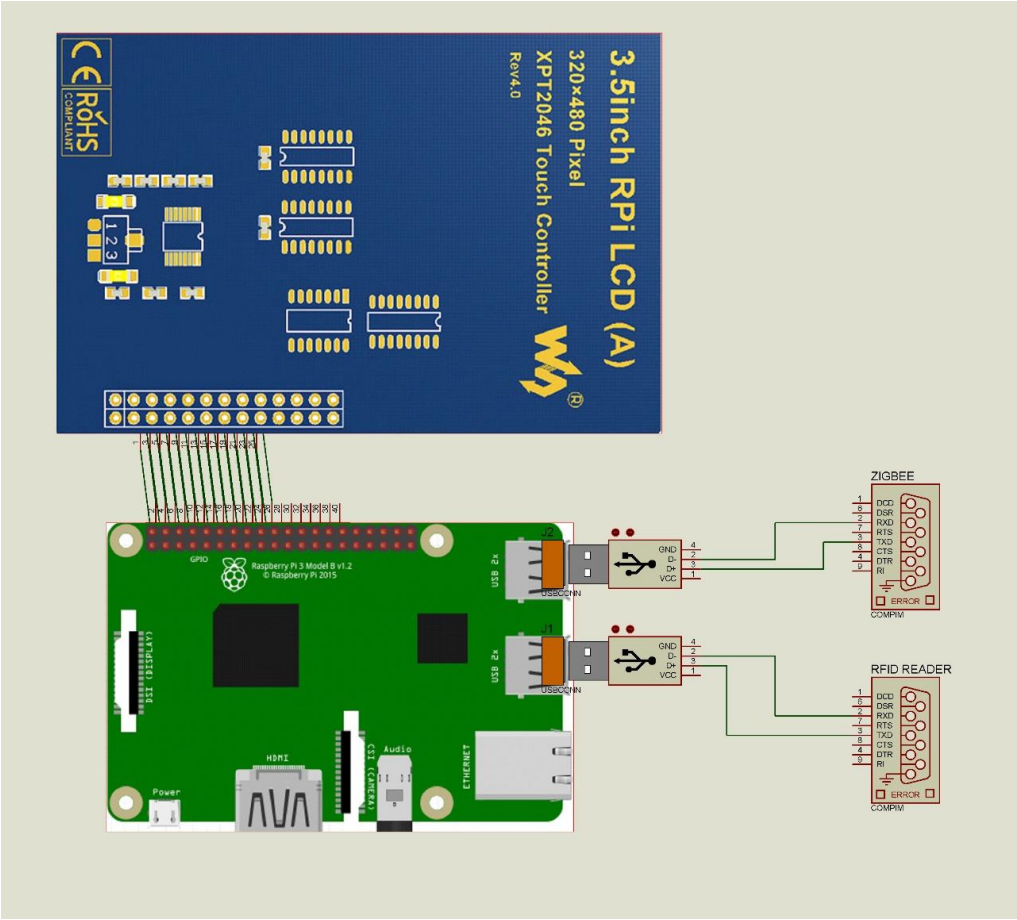

Figure 3.2 Circuit Design

The Raspberry Pi board (Pi3) operates on 5.1 V which is supplied through USB from PC. Input Power Pins 1 ,17 of LCD are connected to 1,17 pins of Pi which are 3.3V , Positive Input power Pins 2,4 of LCD are connected to 2,4 Pins of Pins which are 5V,Pins 6,9,14,20,25 of LCD are connected to Ground pins of Pi. Pins 11,18,19,21,22,23,24,26 of LCD are connected to GPIO17,24,MOSI,MISO,GPIO25,SCLK,CS0,CS1 of Pi and Pins 3,5,7,8,10,12,13,15,16 of LCD are connected to SDA,SCL,GPIO4,UART0 TX, UART0 RX,GPIO's 18,27,22,23 respectively. 2,3 Pins of two USB ports are connected to TXD and RXD of Reader and Zigbee respectively .

3.3 Flowchart depicting the working of proposed model

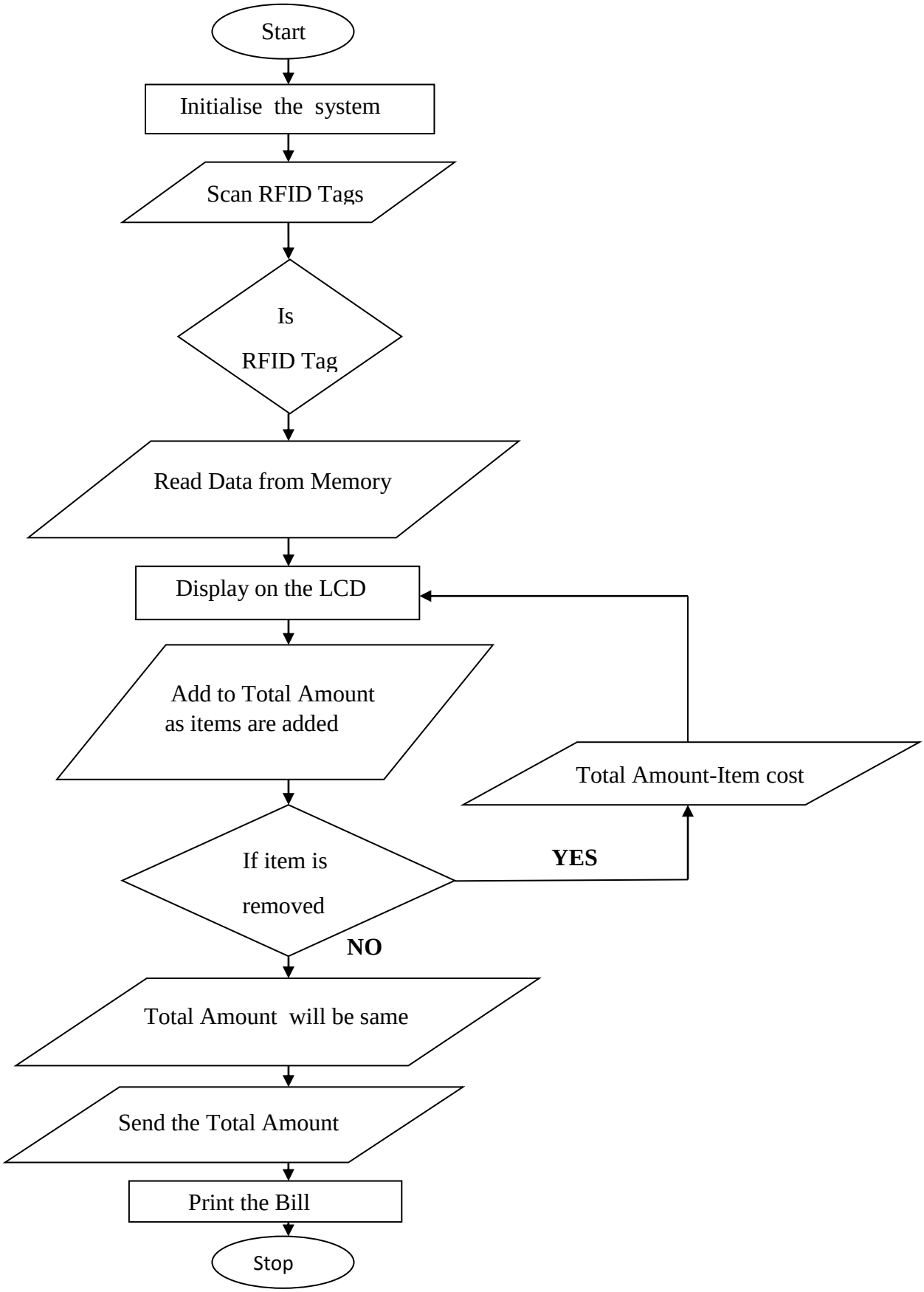

Figure 3.3 Flow chart of the proposed system

In Figure 3.3 the flow chart of the proposed system is shown. It states that after initialising the system the reader will scan for RFID tags. If RFID tag is found reader reads the tag and sends the information to microcontroller which then compares it with data stored in memory.If the tag matches with the data stored it will display data on the LCD. If items keep on adding it goes on adding to the total amount. If item from trolley is removed then it deducts cost of that specific item from total amount. Then after adding of items is done total amount is send to Central billing unit .

3.4 Hardware Specifications

3.4.1 Raspberry Pi3

Figure 3.4 shows Raspberry Pi3 which is used as microcontroller in our proposed system.

Figure 3.4 Raspberry Pi3

It is the third generation RaspberryPi. This strongly built credit card sized single board computer can be used for various implementations and dominates Raspberry Pi Model B+ and Raspberry Pi2 Model B. This is ten times faster than the first generation Raspberry Pi. Besides it possess the wireless LAN and Bluetooth Connectivity making it excellent solution for many connected designs. This is operated with 5.1V micro USB supply. Generally it uses amidst 700-1000mA depending on what peripherals are connected.The maximum power Raspberry Pi can use is 2.5Amp.The power requirements of the Raspberry Pi increase depending on different interfaces attached to it. The GPIO pin uses 16mA safely,The HDMI port uses 50mA ,the camera module uses 250mA ,the keyboard and mice can take as small as 100mA or above 1000mA.

Technical Specifications

- Broadcom BCM2387 chipset
- 1.2 GHz Quad Core ARM Cortex- A53

- 1 GB RAM
- 64 Bit CPU
- 4 x USB ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- 10/100 Base T Ethernet Socket
- CSI camera port
- DSI display port
- Micro SD port for loading your operating system and storing data
- Micro USB power source

Characteristics

- 10x faster
- Completely HAT Compatible
- 40 pin extended GPIO to enhance your real time projects
- Streams High Definition Output at 1080

3.4.2 Set Up of Raspberry Pi

First we need to boot Raspberry Pi ,for this when pi is powered up it tries to communicate to an attached SD card and looks for a file called bootcode.bin; if it finds then it loads into memory and leaps to it. This code then continues to load up the rest of the Pi system.

For dumping the code in to Raspberry Pi ,the process is as follows:

Figure 3.5 details the way for double clicking on the Python symbol.

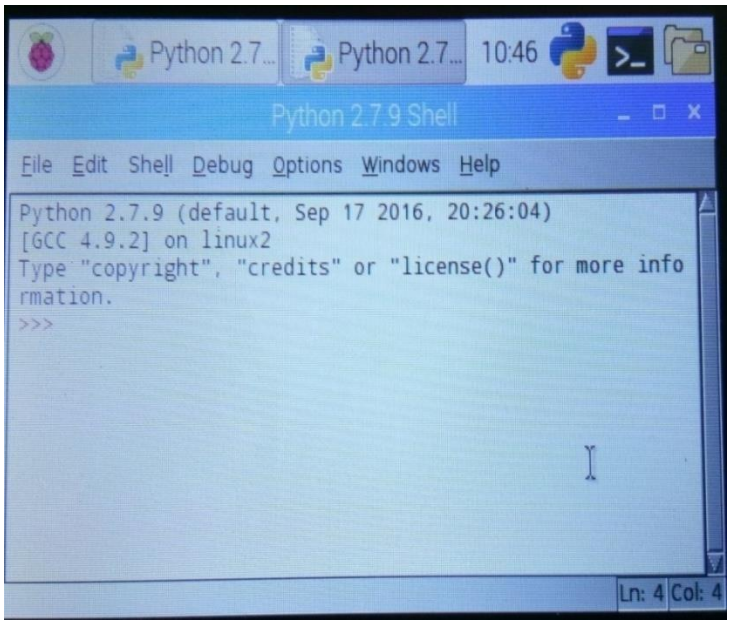

Figure 3.5 Double clicking on the Python symbol

In Figure 3.6 how the opening of the file in Python version takes place is shown.

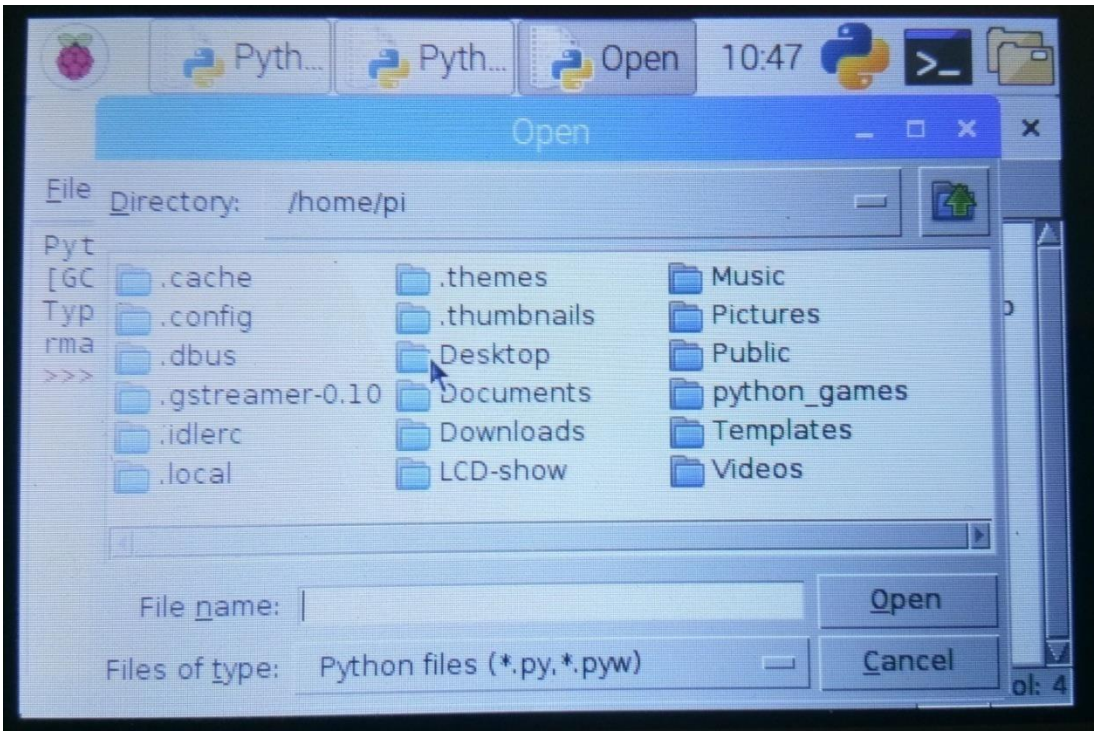

Figure 3.6 Opening the file in Python version

Figure 3.7 shows how to go to desktop and to double click in order to open the main file.

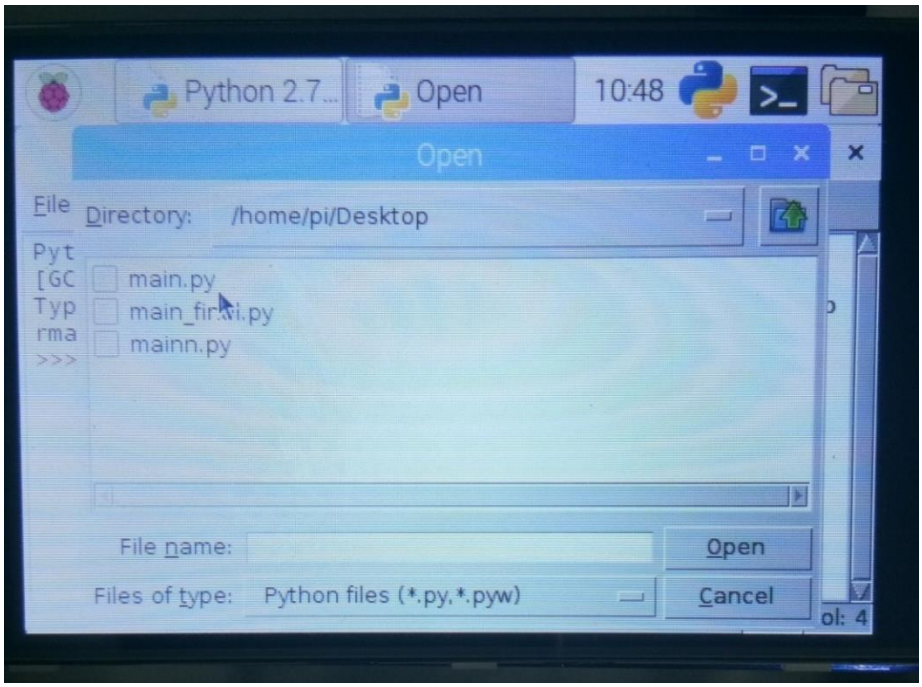

Figure 3.7 Opening of main file

Figure 3.8 details the procedure for writing the code for a program by opening the main.py file .

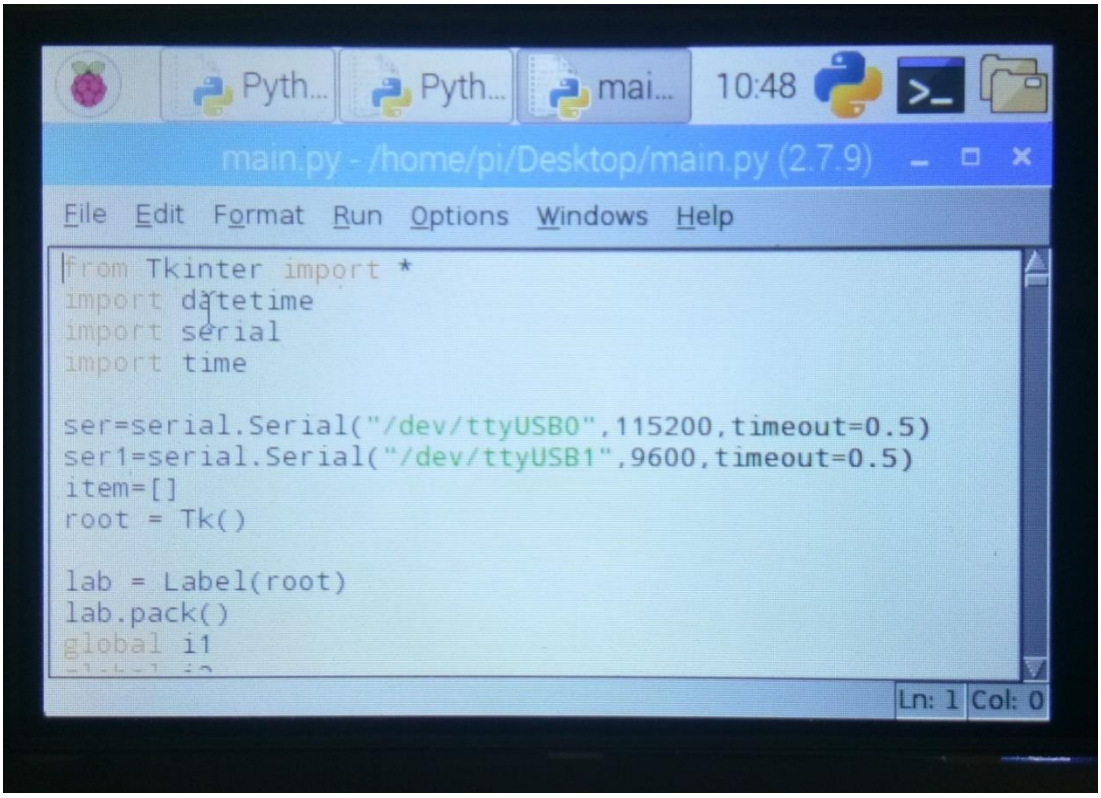

Figure 3.8 Writing Code in file

Figure 3.9 describes the way to run the file after writing the code by clicking on Run Option.

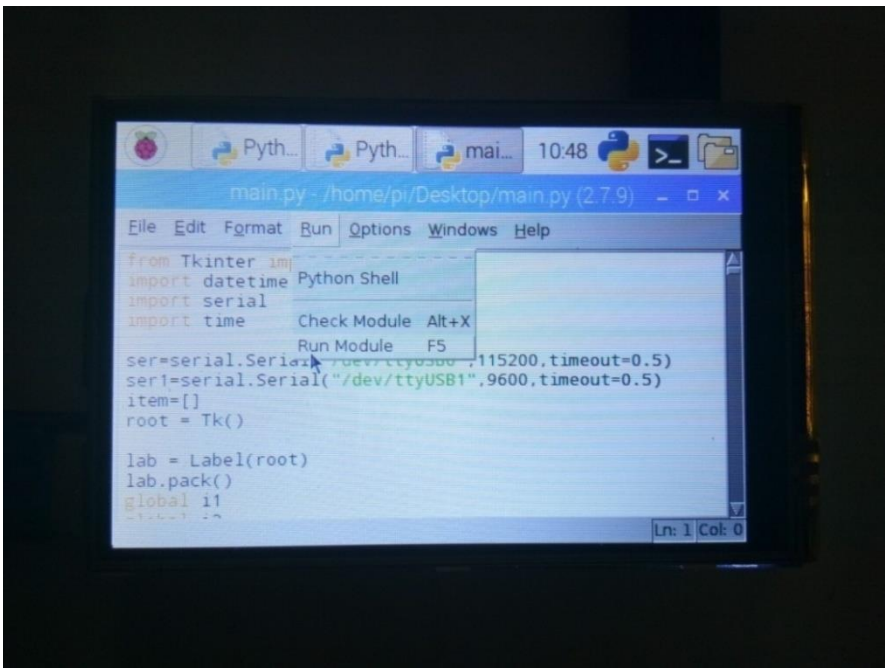

Figure 3.9 Running the file

Figure 3.10 details how to see the reader working after connecting the reader to pi through USB after a bit of warning declarations on screen .

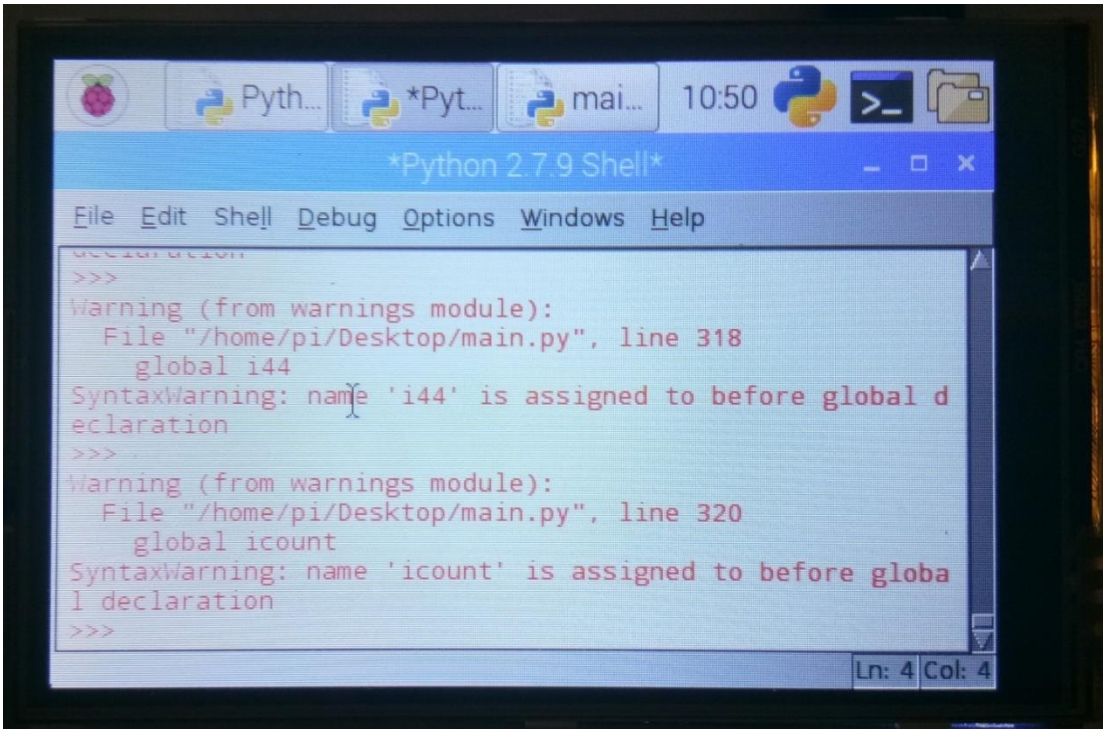

Figure 3.10 Declaration of Warnings

3.5 RFID Reader

The RFID Reader selected for this project is uhf rfid of model YR9010. It's dimensions are as 120x85x20mm. It works in the frequency range of 902 Mhz- 928 Mhz or either in the range of 865Mhz-868Mhz. It works with the voltage of 3.5V-5V and the output power will be in the scope of 0dbm-26dbm. It is a multiconnector and can communicate with the many interfaces like USB 2.0,RS232,Wiegand 26 and Wiegand 34. It can read up to 50 tags/sec depending on antenna, tag and application. It's reading capability varies from 10cm-3m depending on tag, antenna and implementation. It has a communication baud rate of 115200bps(default) and operating current will be 180mA at 3.5V (26dBm output,25°C) and as 110mA at 3.5V (18 dBm output,25°C).It can be used as Desktop reader and also as a entry guard machine.

Figure 3.11 shows the RFID Reader and its peripherals which is used in our proposed system.

Figure 3.11 RFID Reader

Tabel 3.1 explains the different pins of reader specifying their functions.

Tabel 3.1 Description of Reader pins

PIN	Definition	Explain
1	+9V	External 9 V power supply. （Note: can't connect the external power supply and USB at the same time.）
2	GND	With + 9 v external power supply common grounding.
3	RS-232 TXD	RS-232 data output.
4	RS-232 RXD	RS-232 data input.。
5	GND	With RS-232 connector common grounding.
6	GPIO3	GPIO3 or WiegandData 0。
7	GPIO4	GPIO4 or WiegandData 1。
8	GND	with Wiegand Data common grounding.

3.5.1 Reader Set Up

The RFID reader is first tested using the SDK (software development kit) provided by YR9010 reader itself which helps in testing and debugging. The SDK is compiled in C# language. Its firmware version is 1.9. The RFID reader besides RS232 also supports connecting through RS 485 and wireless connection through ethernet using TCP/IP protocol. This project is taking UHF RFID reader as the read range required is less than one meter depending on cart dimensions .

The SDK has option to select the COM port for RS232 connection and to set the baud rate for the reader. The default baud rate of the reader is 115200. Through this SDK we can select GPIO, set RF output power and frequency. The Fig 3.8 is a picture of the SDK and how to use it.

For this experiment COM port 1 has been connected to the reader and the baud rate through which computer is connected is 115200, which is written in the code. The RF output power can be set from 10-26 dbm. This reader is connected with USB to the RaspberryPi Board.

Figure 3.12 describes the Demo version of Reader which is referred as SDK(small Development Kit) where we can analyse the reader working.

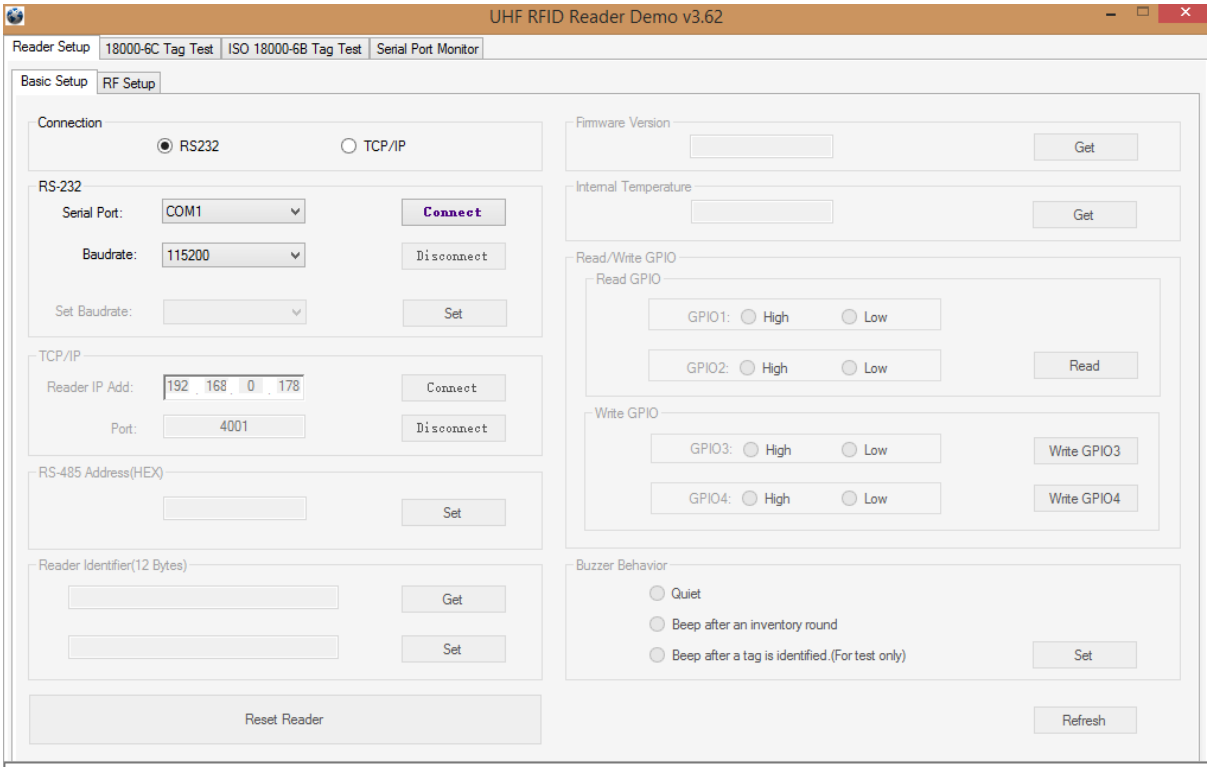

Figure 3.12 SDK of YR9010

After setting the baud rate, output power, next is the RF setup where the frequency can also be altered. The reader beeper mode is always kept ON for detecting if the tag is in the read range.

3.5.2 Tag testing

The testing of tag is done in the SDK in the Tag inventory in real mode, there are two modes for the testing, one is the caching pattern and another is the real time mode. For the cache pattern namely, firstly, put into reader the cache after reading the tag number of EPC ;finally ,to upload multiple EPC data together when needed. The real time mode immediately uploads after reading the tag number of EPC, and recognises next tag after the data uploaded finished. Real-time model has quick response of advantage, the user can get the label data in the first time with no delay. And can get real-time tag at different times and different locations of RSSI (tag signal strengthindicate), frequency parameters (read tag carrier frequency).The Fig 3.13 shows that five tags have been read

Serial Monitor: this monitor shows the incoming and outgoing signals (hexadecimal codes) for each task being performed. The codes appear in two color blue and red. Blue is for the bytes that are going to the reader from the computer i.e the command the user is giving and red is the response packet from the reader in reply to the command.

Figure 3.13 shows how testing of tags is done real time mode in the SDK in the Tag Inventory.

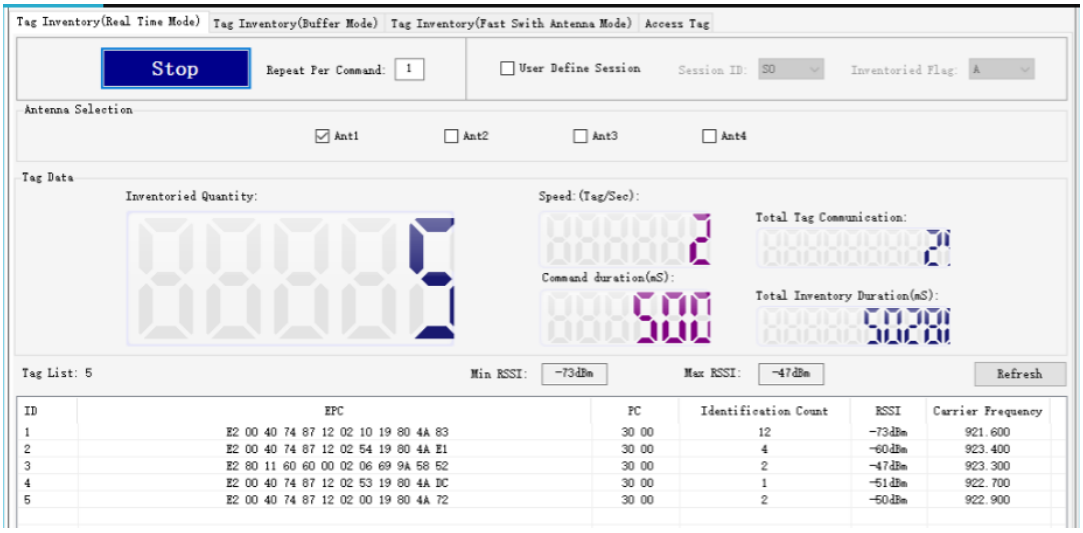

Figure 3.13 Testing of tags in real time mode

Figure 3.14 shows the incoming and outgoing signals (hexadecimal codes) for each task being performed in Serial Monitor.

Figure 3.14 Serial Monitor

3.5.3 Working and testing

The main steps involved in testing of the system is:

- Sending data to the reader
- Receiving data from the reader

- **Sending data to the reader**: As the reader can understand only hexadecimal values, an array of data is initialized to turn the antenna ON and send data i.e.; *request[7] = {0xA0,0X04,0X01,0X89,0X01,0XD1,0X00};* . Similarly, different arrays of each tag were initialized and stored.

- **Receiving data from the reader:** As the reader receives the signal, it responds by sending an array of data, the one which is stored in the buffer. For this project only the unique ID of the tag is being stored in the program, which were read during the reader configuration and tag testing process.

Figure 3.15 shows bunch of data given by the reader for each and every tag for certain interval of time.

0: ['	0: ['	0: ['			0: ["	0: ["	0: ["			0: ['	0: ['	0: ['			0: ['	0: ['
1: x01	1: x01	1: x01			1: x00	1: x00	1: x01			1: x00	1: x00	1: x01			1: x00	1: x01
2: x89	2: x89	2: x89			2: x00	2: x00	2: x89			2: x00	2: x00	2: x89			2: x00	2: x89
3: x00	3: x00	3: x00			3: x00	3: x00	3: x00			3: x00	3: x00	3: x00			3: x00	3: x00
4: x00	4: x00	4: x00			4: x01	4: x01	4: x00			4: x01	4: x01	4: x00			4: x01	4: x00
5: x00	5: x00	5: x00			5: xc1	5: xc1	5: x00			5: xc1	5: xc1	5: x00			5: xc1	5: x00
6: x00	6: x00	6: x00			6: xa0	6: xa0	6: x00			6: xa0	6: xa0	6: x00			6: xa0	6: x00
7: x00	7: x00	7: x00			7: x13	7: x13	7: x00			7: x13	7: x13	7: x00			7: x13	7: x00
8: x00	8: x00	8: x00			8: x01	8: x01	8: x00			8: x01	8: x01	8: x00			8: x01	8: x00
9: x00	9: x00	9: x00			9: x8900	9: x89H0	9: x00			9: x89', '0	9: x89l0	9: x00			9: x89$0	9: x00
10: xcc	10: xcc	10: xcc			10: x00	10: x00	10: xcc			10: x00	10: x00	10: xcc			10: x00	10: xcc
11: xa0	11: xa0	11: xa0			11: xe2	11: xe2	11: xa0			11: xe2	11: xe2	11: xa0			11: xe2	11: xa0
12: x13	12: x13	12: x13			12: x00Qy	12: x00Qy	12: x13			12: x00AD	12: x00AD	12: x13			12: x00QB	12: x13
13: x01	13: x01	13: x01			13: x98	13: x98	13: x01			13: x82	13: x82	13: x01			13: x05	13: x01
14: x8940	14: x8900	14: x89,0			14: x18	14: x18	14: x89,0			14: x01	14: x01	14: x89			14: x10	14: x89T0
15: x00	15: x00	15: x00			15: x01'	15: x01'	15: x00			15: x02g	15: x02g	15: x080			15: x00	15: x00
16: xe2	16: xe2	16: xe2			16: x19	16: x19	16: xe2			16: x18PT	16: x18PT	16: x00			16: x12	16: xe2
17: x00@	17: x00@	17: x00@			17: x00P	17: x00P	17: x00Qy			17: x89D	17: x89FI	17: xe2			17: x14	17: x00QB
18: x00x	18: x00x	18: x00x			18: x06@0	18: x06C	18: x98			18: xab	18: xa0']	18: x00AD			18: x10	18: x05
19: x06	19: x06	19: x06			19: xa0"]	19: x15	19: x18			19: xa0']		19: x82			19: x84	19: x10
20: x00I	20: x00I	20: x00I				20: xa0"]	20: x01'					20: x01			20: xa9D>	20: x00
21: x06P	21: x06P	21: x06P					21: x19					21: x02g			21: xa0']	21: x12
22: xd6(<	22: xd6(F	22: xd6(D					22: x00P					22: x18PT				22: x14
23: xe6	23: xe0	23: xe6					23: x06@4					23: x89@				23: x10

Figure 3.15 Data sent by reader for various Tags

3.6 Touch screen LCD (Liquid Crystal Display)

3.6.1 Interfacing of LCD with Raspberry Pi

Firstly install the driver: LCD-show-170703.tar.gz, network connection is required while installing. Follow the below steps one after other
1.Configure your Pi with the following Command:

- sudo raspi-config

Then Select Expand File System ,Boot option is Desktop Autologin and the boot option may vary according to Raspbian version.

2. Copy the Driver into your OS and run the following Commands

- tar xvf LCD-show-*.tar.gz
- cd LCD-show/

3. Install the driver and it adjusts the mode to LCD Display

- chmod +x LCD35-show
- ./LCD35-show

4. After system rebooting LCD is ready to use

We have created a GUI (Graphical User Interface) page on the screen where can we get update of all items list with name , respective cost and total amount of all items.

In addition to this we have two options on the screen like

1) Refresh – which is used to refresh the items list on the screen.
2) Send – which is used to send the items list and total cost to the Central Billing unit through Zigbee.

Figure 3.16 shows the display of GUI (Graphical User Interface) page on LCD.

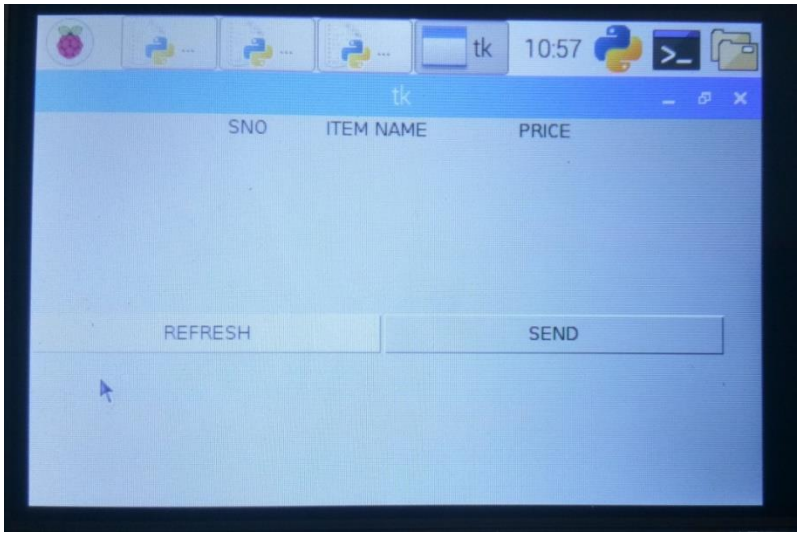

Figure 3.16 GUI page display on LCD

Characteristics

- 320x480 resolution
- Resistive Tap control
- Assists any model of Raspberry pi
- Drivers Provided (works with your own Raspbian/Ubuntu directly)
- Size flawlessly fits with Pi
- Excellent concentration of Gold Surface Plating
- Supports Raspbian system, equip your system
- Support Software keyboard(system interaction without keyboard/Mouse)

3.6.2 Key Variables

Tabel 3.2 details the key variables of LCD with their respective descriptions.

Tabel 3.2 Key variables of LCD

LCD Type	TFT
LCD Interface	SPI
Touch Screen Type	Resistive
Touch Screen Controller	XPT2046
Colors	65536
Backlight	LED
Resolution	320*480 (Pixel)
Aspect Ratio	8:5
Power Consumption	TBD
Backlight Current	TBD
Operating Temp. (℃)	TBD

3.6.3 Pins Description

Tabel 3.3 shows the description of various pins with their respective pin numbers and symbols.

Tabel 3.3 Description of LCD pins

PIN NO.	SYMBOL	DESCRIPTION
1, 17	3.3V	Power positive (3.3V power input)
2, 4	5V	Power positive (5V power input)
3, 5, 7, 8, 10, 12, 13, 15, 16	NC	NC
6, 9, 14, 20, 25	GND	Ground
11	TP_IRQ	Touch Panel interrupt, low level while the Touch Panel detects touching
18	LCD_RS	Instruction/Data Register selection
19	LCD_SI / TP_SI	SPI data input of LCD/Touch Panel
21	TP_SO	SPI data output of Touch Panel
22	RST	Reset
23	LCD_SCK / TP_SCK	SPI clock of LCD/Touch Panel
24	LCD_CS	LCD chip selection, low active
26	TP_CS	Touch Panel chip selection, low active

3.7 RFX240 Zigbee Module

RFX240 is minimised to a greater extent to supply all suitability of transfer of power intensification for IEEE 802.11b/g/n implementation in the 2.4GHz frequency range.It produces a gain of 30db and a range of +26dbm of linear output power with low EVM of less than 3percent for 802.11n MCS7 HT40 signals. It has argument control for CMOS, input impedance matching for on chip along with mixed RF decoupling for the electricity supply. It is constructed in a optimised 3.0x3.0mm 16L-QFN package. It requires less outward elements to significantly make easier the RF Front end implementation.

In this project we have connected one zigbee to the USB port of Raspberry Pi and other Zigbee to the USB port of PC which acts as Central billing unit.

Figure 3.17 shows the RFX240 Zigbee Module which is used in our proposed system.

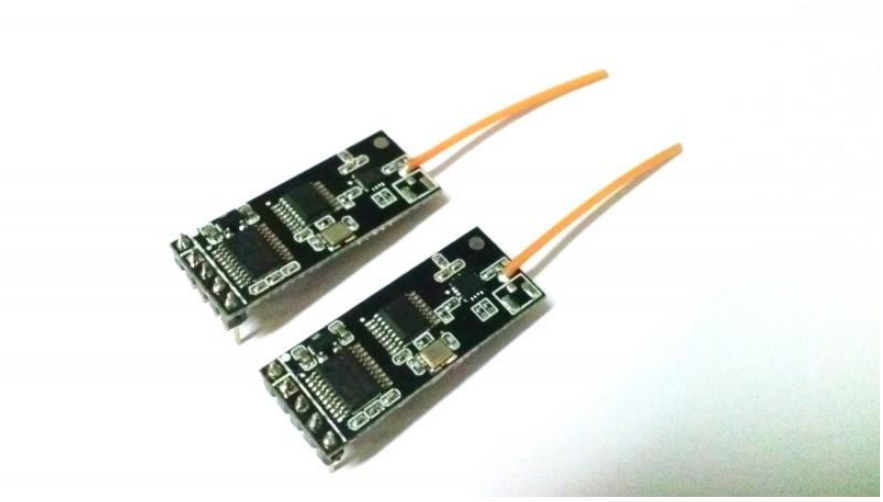

Figure 3.17 RFX240 Zigbee Module

3.7.1 Applications

- Excessive power WLAN AP/Routers
- Exterior WLAN Hotspot
- Set-Top Box/Home Gateway
- Wi-Fi Extenders
- Wi-Fi Electronic devices
- Enterprise/SOHO Wi-Fi Networks

3.7.2 Features

- Very Less DC power Consumption
- DC Decoupled RFports
- 50 ohm input/output matching
- Very less External Elements required
- Consistent with low voltage(1.2V) CMOS control logic levels or levels upto VDD
- High gain of 30db
- ESD Protection circuitry on all ports
- Mixed power indicator for transfer of power monitoring and control

- Great transfer signal proportionality meeting standards for OFDM/CCK Modulation.
- Inward RF decoupling on all VDD bias pins

3.7.3 Device Pin-Out

Figure 3.18 shows the internal connection of Zigbee module with their respective Pins.

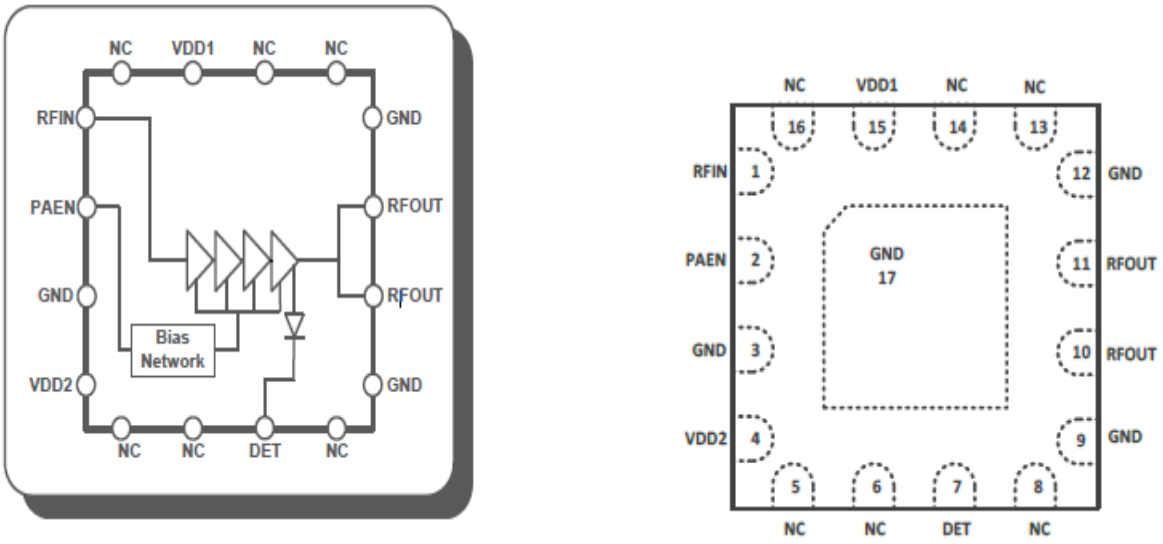

Figure 3.18 Pin out diagram of Zigbee

3.7.4 Device Pin-out Description

Tabel 3.4 shows the description of various pins with their respective pin names and pin numbers.

Tabel 3.4 Description of Device pins

Pin Number	Pin Name	Description
1	RFIN	RF Input Signal to the PA – DC Internally Shorted to GND
2	PAEN	CMOS Logic Control to Enable the PA
3, 9, 12, 17	GND	Ground – Must be Connected to Ground in the Application Circuit
4, 15	VDD1, VDD2	DC Supply Voltage
7	DET	PA Power Detector Voltage Output
5, 6, 8, 13, 14, 16	NC	Not Connected Internally
10, 11	RFOUT	RF Output Signal from the PA

- VDD : 3.3V or 5V power supply positive
- GND : power negative
- TXD : serial output module connected to microcontroller or USB to serial TXD
- RXD : serial input module connected to microcontroller or USB to serial RXD
- CMD : enter upgrade mode or AT mode pin ,active low

3.7.5 Transfer Characteristics

(VDD = 5.0V, PAEN = HI, TA = +25°C, unless otherwise specified, as measured on the RFX240 evaluation board, de-embedded to the device.**)**

Tabel 3.5 shows the properties which detail the gain and loss of different input and output parameters along with their respective types, units, minimum and maximum values and their working conditions.

Tabel 3.5 Transfer Properties of Zigbee Module

Parameters	Min	Typ	Max	Units	Conditions
Operating Frequency Band	2.4		2.5	GHz	All RF Pins Terminated by 50 Ohms
Output P1dB		+32		dBm	CW
Linear Output Power (802.11n)		+25.5		dBm	802.11n MCS7 HT20 <30dB DEVM
Linear Output Power (802.11b)		+26		dBm	1Mbps CCK Mask Compliance
Small-Signal Gain		30		dB	CW
Second Harmonic		-70		dBc	P_{OUT} = +29dBm, CW
Third Harmonic		-70		dBc	P_{OUT} = +29dBm, CW
Input Return Loss		-15		dB	At RFIN Pin
Output Return Loss		-5		dB	At RFOUT Pins
TX Quiescent Current		210		mA	No RF Input Signal
TX Linear Current		420		mA	P_{OUT} = +26dBm, 11n MCS7 HT20
Power Detector Voltage Output		0.2-0.9		V	5dBm to +27dBm, 10KΩ Load
Load VSWR for Stability (CW, Fix Pin for P_{OUT} = +29dBm with 50Ω Load)	4:1	6:1		N/A	All non-harmonically related spurs less than -43 dBm/MHz
Load VSWR for Ruggedness (CW, Fix Pin for P_{OUT} = +29dBm with 50Ω Load)	8:1	10:1		N/A	No damage

3.8 RFID Passive Tags

Figure 3.19 shows the various types of passive tags

Figure 3.19 Passive Tags

Passive tags are also known as Battery less tags. Price per each tag may vary few cents to ten or twenty euros depending on frequency, formfactor, packaging etc. This tags have no inward power generators and are driven by the electromagnetic energy supplied from the RFID Reader. The lesser price per tag makes availing RFID systems beneficial and inexpensive for many industries.

Applications

- Admittance Management
- Data Tracing,
- Contest Scheduling,
- Supply chain management,
- Elegant designing

3.8.1 Working

Usually three main parts constitute an Passive RFID system. They are
i)RFID Reader
ii) RFID antenna and
iii) RFID tags

When Compared to active tags the standard passive tags have only two components. They are:
i)Tag Antenna and
ii)Microchip or Integrated circuit(IC)
This standard structure is usually mentioned as RFID inlay.

As the name itself refers passive, these tags normally holdup for a signal from reader.

The Reader discharges energy to the antenna whereby the antenna converts that energy into radiofrequency waves which are thereby sent to the readzone. After the tag getting read with in the readzone ,the antenna which is present in passive tag gets energy from the RF waves. The energy there from the tag antenna moves to chip and produces a signal back to the system.This is called as backscatter. The backscatter or alter in electromagnetic or RF wave is identified by the reader (through the antenna) which interprets the data.

Passive tags do not operate at all frequencies. Along with the frequency range there are many factors like readrange, materials attached ,type of application with the which the working gets influenced. There are three important frequencies with which passive tags operate. They are

Low Frequency(LF)

125-134-KHz- This is generally used for animal tracking as this will not be affected by water or metal mostly with a less range of about 1-10 centimeters.

High Frequency (HF) & Near-Field Communication (NFC)

13.56MHz- This is used for information transmits, entry control implementations, DVD stalks, passport defense implementations which do not require a long range with a general range of 1 centimeter to 1 meter .

Ultra High Frequency (UHF)

865 – 960 MHz – Passive UHF tags can read from a average distance of 5-6 meters but larger UHF tags can read up to 30+meters range in ideal conditions.This frequency is used for contest tracing, IT asset tracking, file and laundry management as they need more than meter of read range.
Usually speaking the higher the frequency ,the more the problems with an RFID system as they have nonfriendly RFID materials like water, metal etc

3.8.2 Electronic Product Code (EPC)

The electronic product code(EPC) which is saved in tag's chip memory is written to tag and has form of 96 bit-string of information. In that the first eight bits are used to recognise the type of protocol, the next 28 bits relates the arrangement which manages the data for the tag, the next 24 bits are an object class which determine type of product, the last 38 bits are a distinct serial number for specific tag. The last two categories are set by organisation which issue tag. This total electronic product code number can be used as way into global database to specially identify the item.

Figure 3.20 details the Electronic product code(EPC) and its arrangement of bits in tags chip memory written to tag.

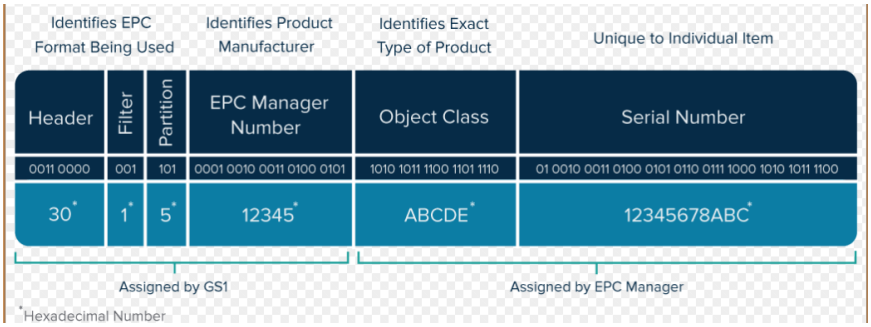

Figure 3.20 Electronic Product Code

Advantages of Passive Tags

- Optimised size
- Lesser Cost
- More Flexibility
- Longer range of read choice
- Life long capability lasting(as they don't have battery)

3.8.3 Passive RFID Inlays

Inlays are generally the most inexpensive RFID tags pricing as small as $0.12 per tag in large quantity eventhough the price doesnot have influence on the performance. If at any circumstances tagging a certain product becomes a problem for particular applications because of deteioration ,embeddable tags will be fitted in mini fissures and covered in adhesive so that tag will not be damaged.

Figure 3.21 shows a pack of passive RFID Inlays.

Figure 3.21 A bunch of Passive RFID Inlays

These inlays can be mainly categorised into three groups. They are:

Dry Inlays:

An RFID microchip(IC) along with antenna attached to a material usually as web. These appear as they have been coated and and as standard with no adhesive.

Wet Inlays

The microchip along with antenna usually attached to a substrate usually PET or PVT adhesive backing. Almost all these inlays look like clear and can be peeled off easily and can be stuck on an product quickly.

Paper FaceTags

These are wetinlays which come with a white paper or polyface and are mostly used for purposes which need printed numbers or symbols on the fore for recognition.

3.9 Hardware Connection

Figure 3.22 show the hardware system connection where the reader and zigbee modules are connected to raspberry pi which is then connected to Central billing unit for billing purpose (here instead laptop is used as Central Billing unit).

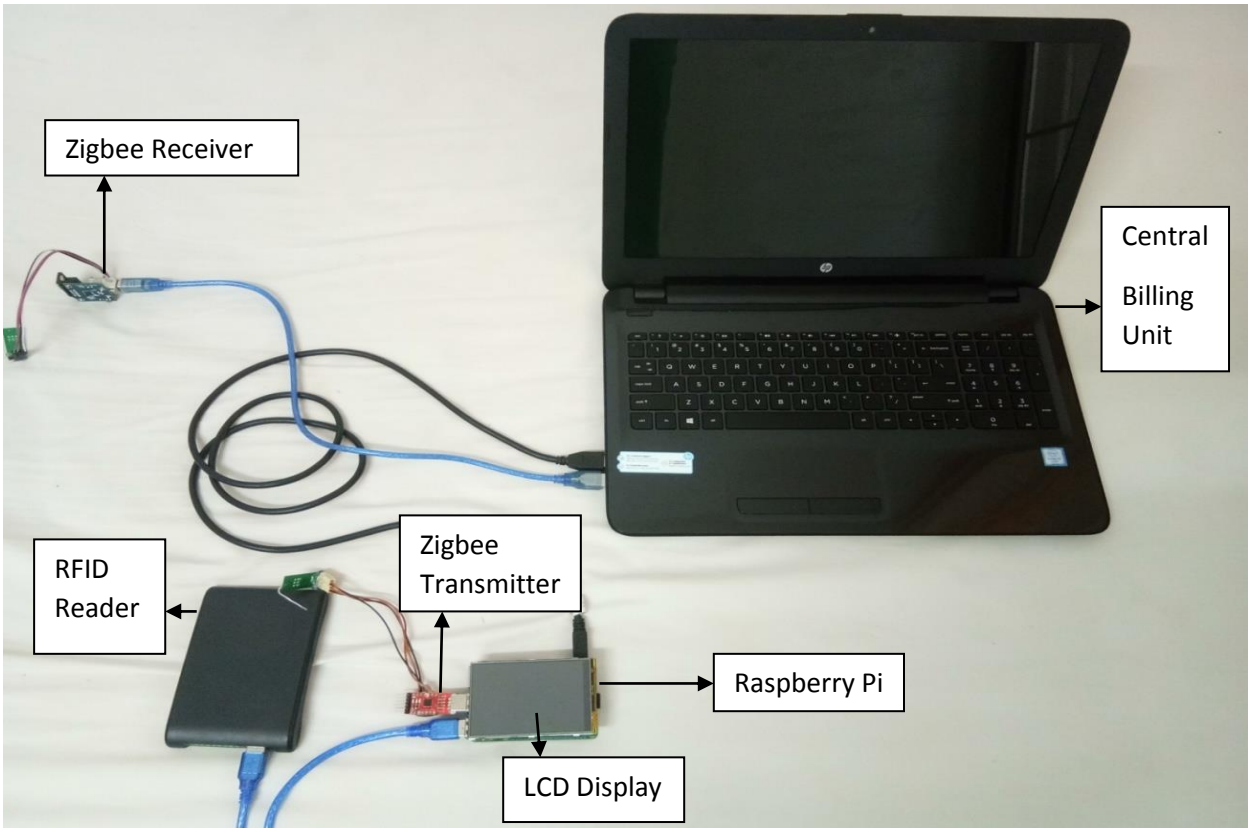

Figure 3.22 Hardware system connection

In Figure 3.23, 3.24 and 3.25 Overall Shopping cart is shown. Touch screen LCD is placed on the pulling edge of trolley and RFID Reader is placed on the inside bottom of the trolley in vertical position attaching to the side of the trolley.

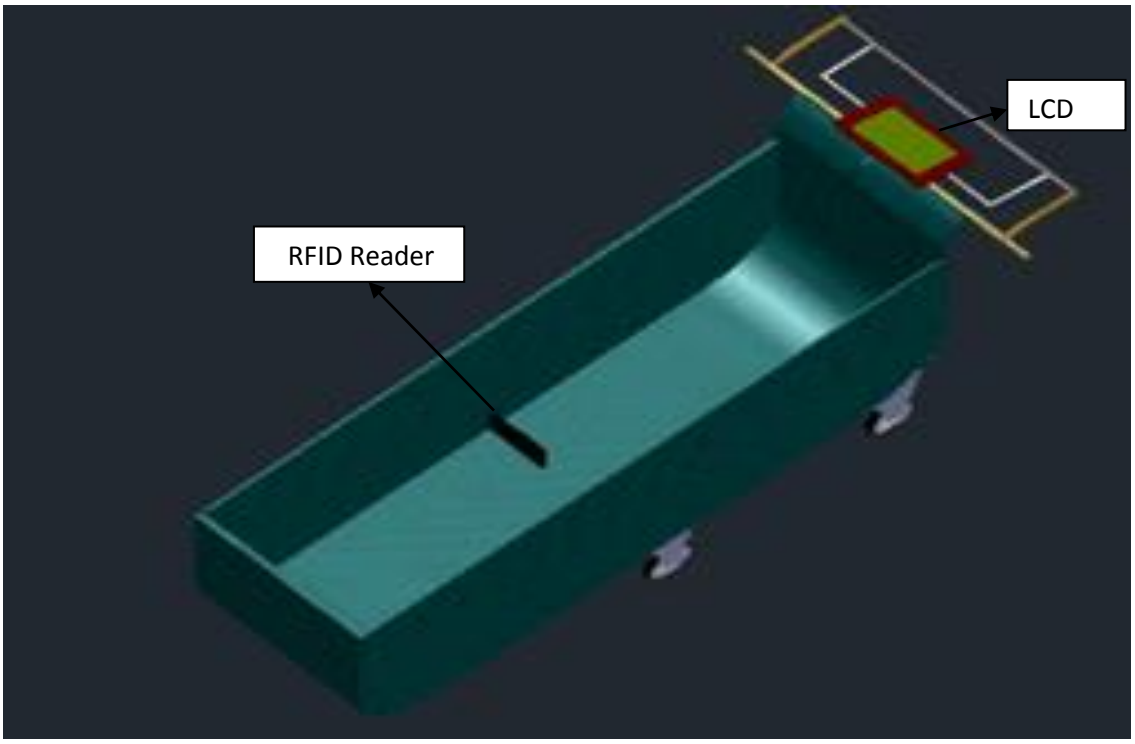

Figure 3.23 Orthogonal projectional view of Trolley

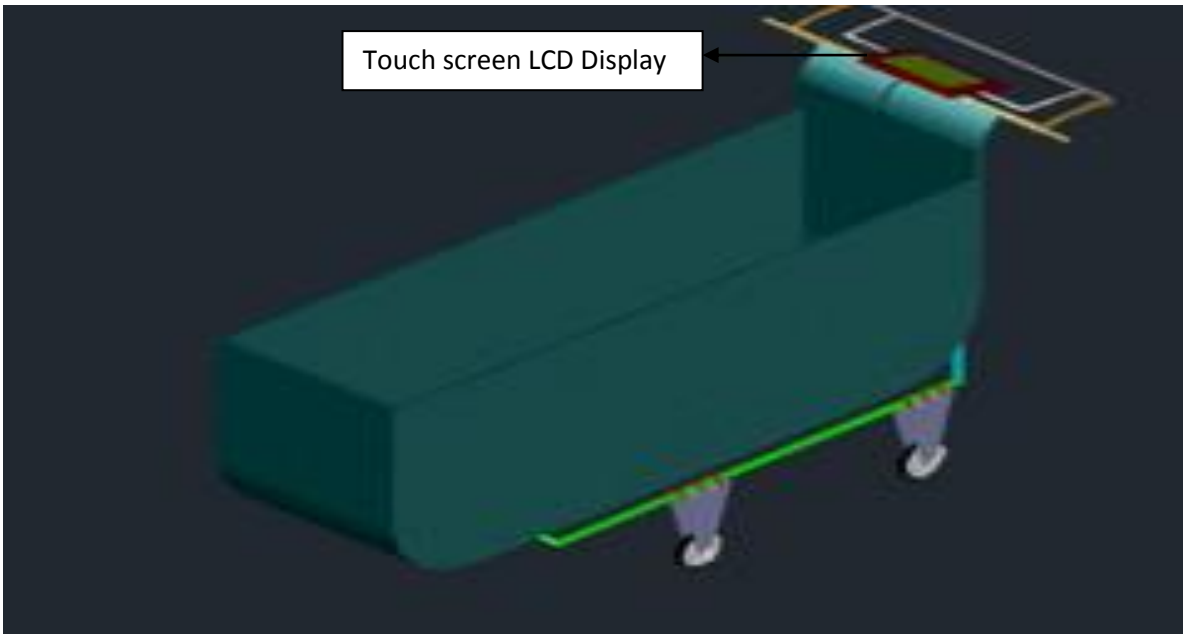

Figure 3.24 Isometric projectional view of Trolley

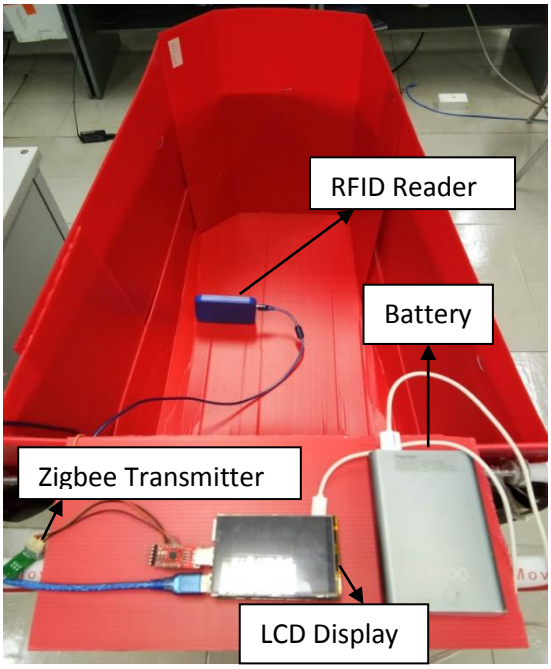

Figure 3.25 Implemented Shopping cart

3.10 Set Up of Zigbee Module

Intially Zigbee module will be connected to PC .We need to identify the port with which the PC gets connected to Zigbee and here is the procedure how to identify and set up the port.

Firstly we need to go to Device manager and we should click on the ports and then we need to update the driver and then we should browse and we should go for next then it gets starting installation of driver software. After Installation we can see the device working properly with the port number assigned and the procedure is as follows.

Figure 3.26 shows how the ports in Device Manager are opened.

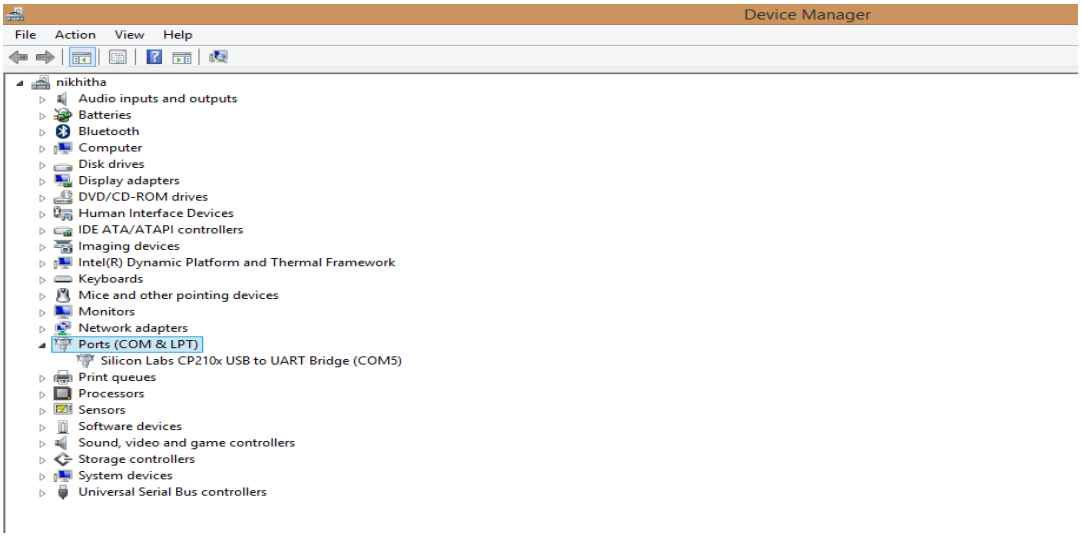

Figure 3.26 Opening the ports

Figure3.27 shows how to open and update Driver.

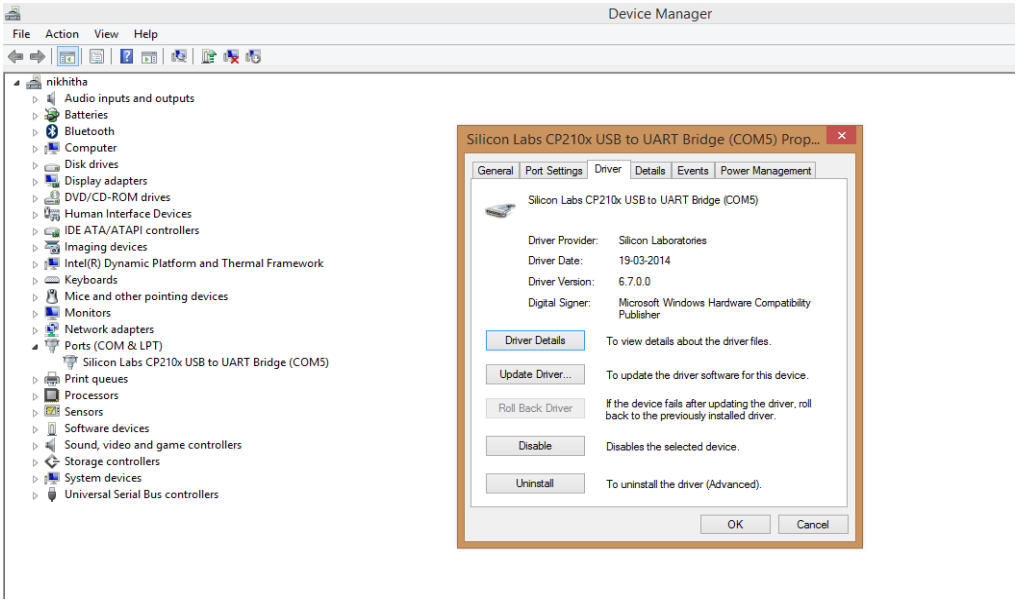

Figure 3.27 Opening driver

Figure 3.28 shows how to browse that from our PC or else how to make the system to select it automatically if we have already installed driver software.

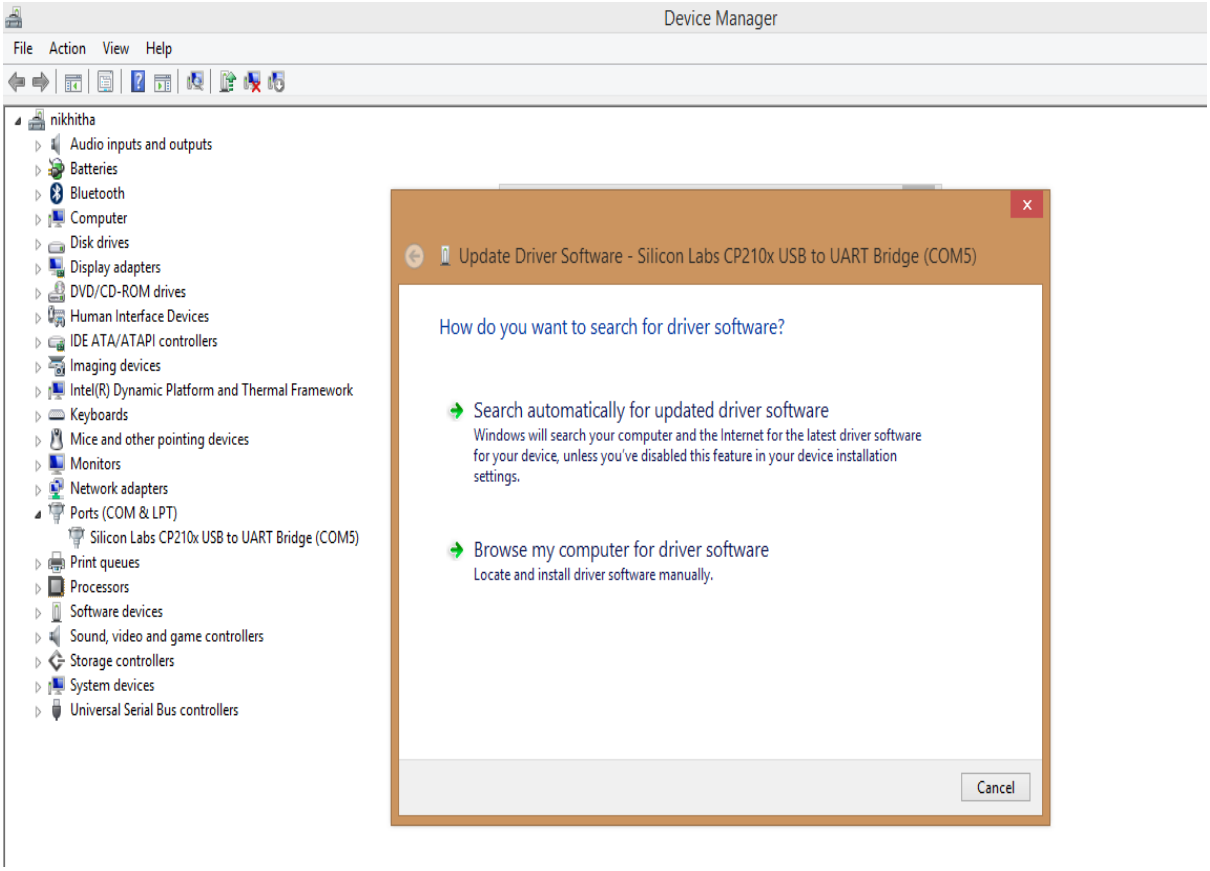

Figure 3.28 Driver software installation

Figure 3.29 shows how to select browse if we have preinstalled or else shows how go to other option and select next for browsing software.

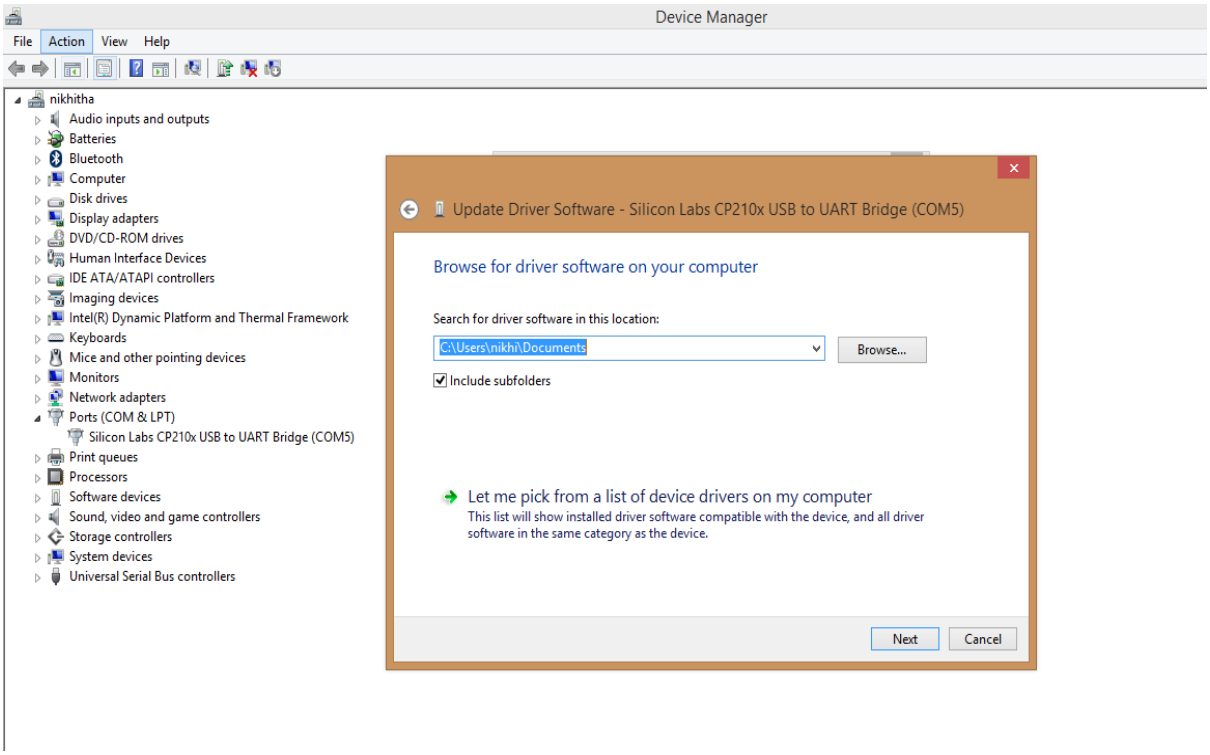

Figure 3.29 Browsing the software

Figure 3.30 shows how PC has updated the driver software .

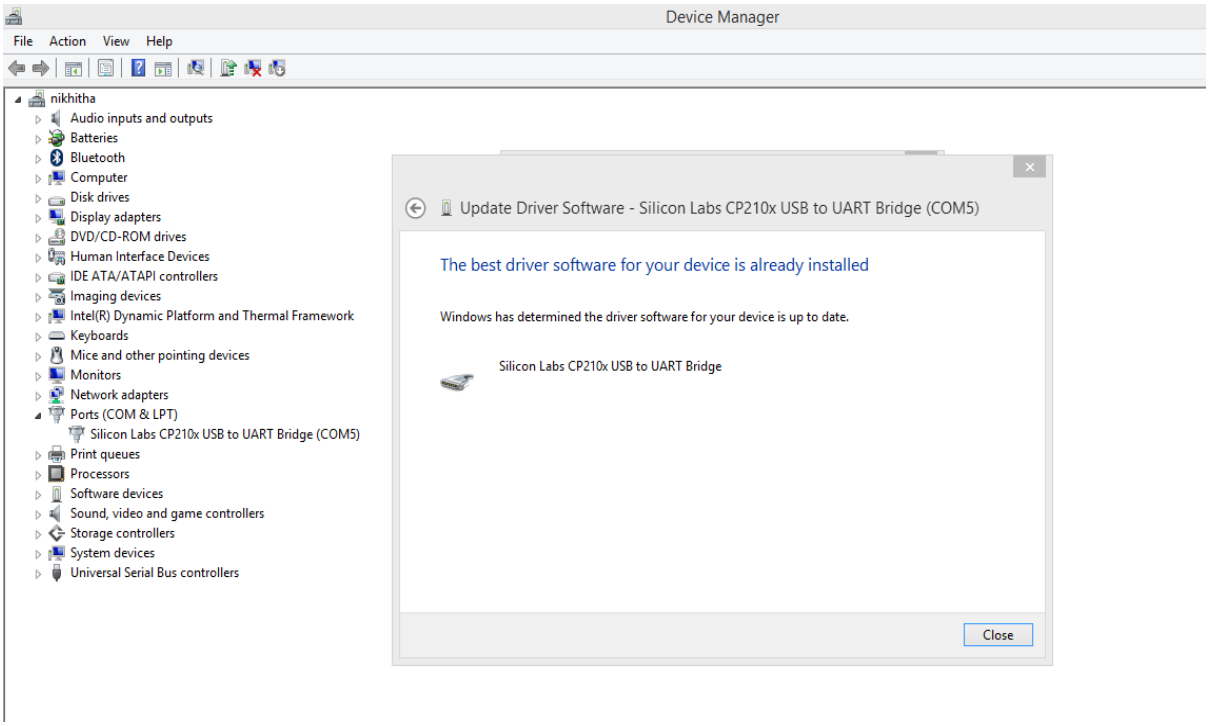

Figure 3.30 Driver software updating

Figure 3.31 shows how we can see the port number and state that device working properly.

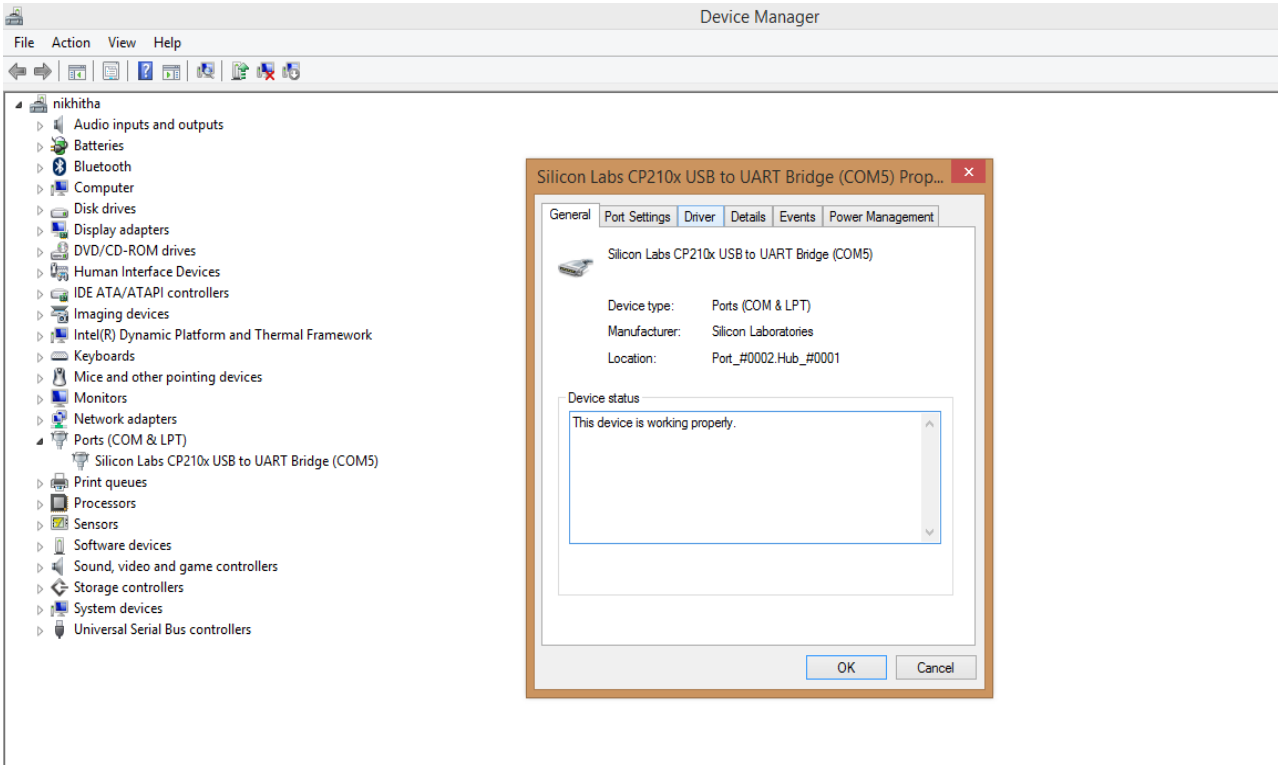

Figure 3.31 Working of Device

Figure3.32 details the procedure to open the application software

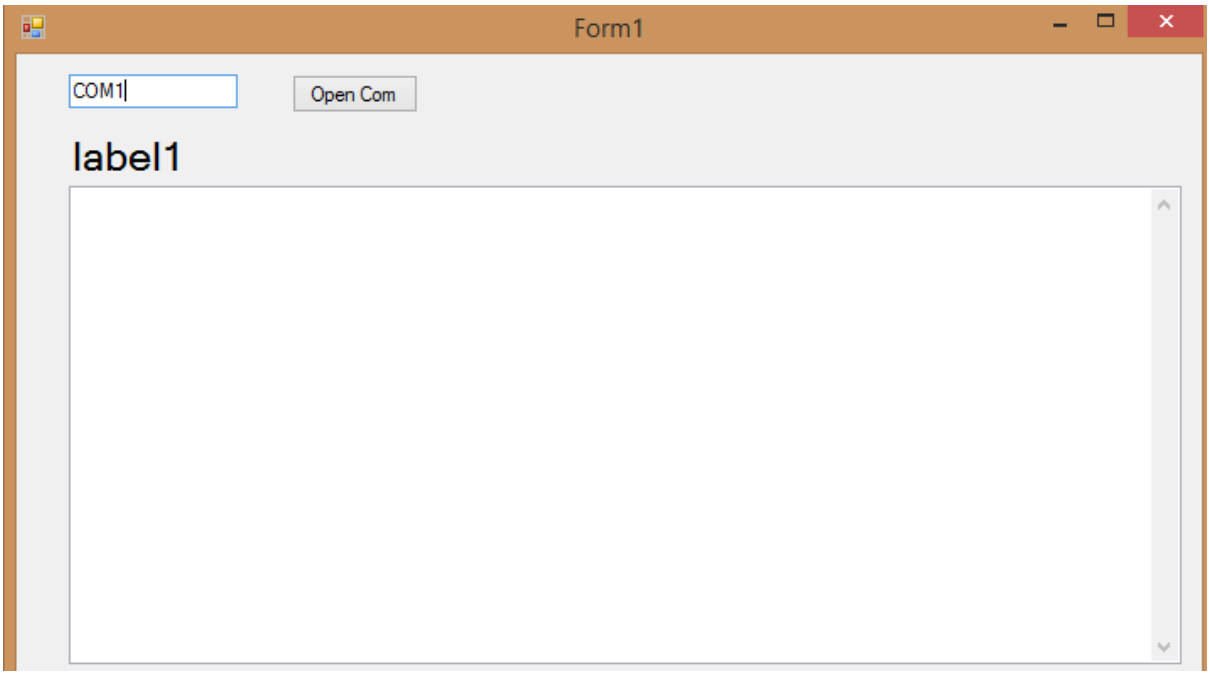

Figure 3.32 Opening of the Application Software

Figure 3.33 shows how to to verify the port number

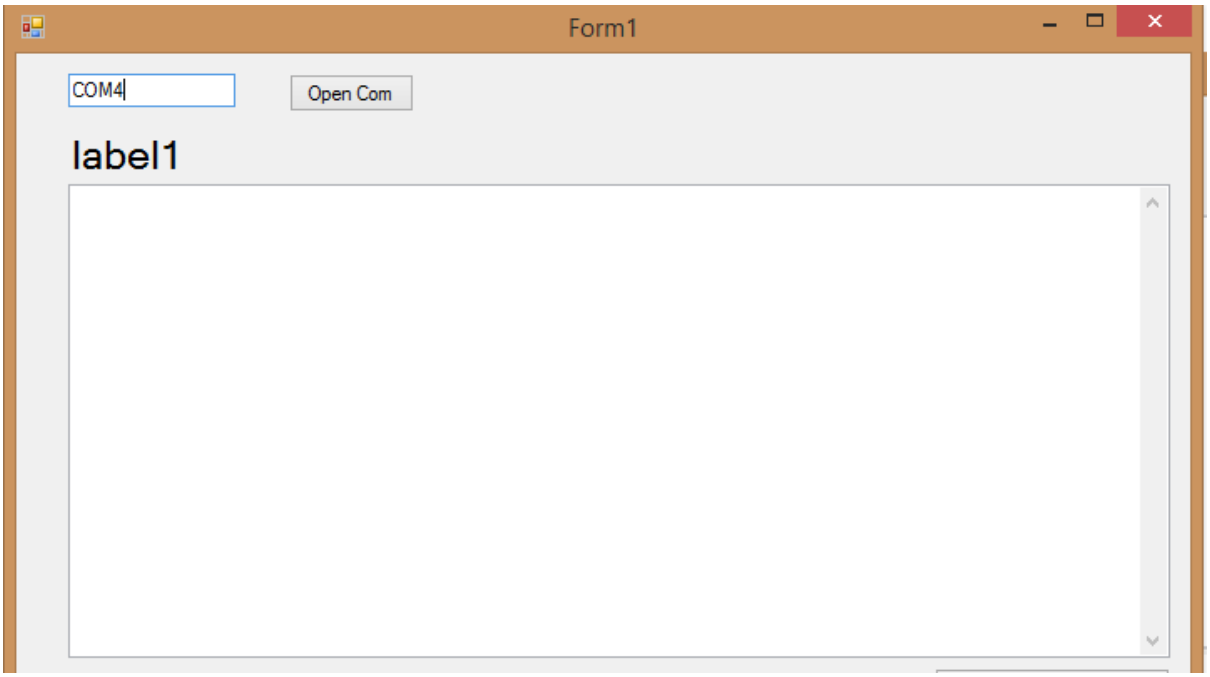

Figure 3.33 Verifying port number

Figure 3.34 details the way of displaying the information sent by user on Central Billing unit Screen

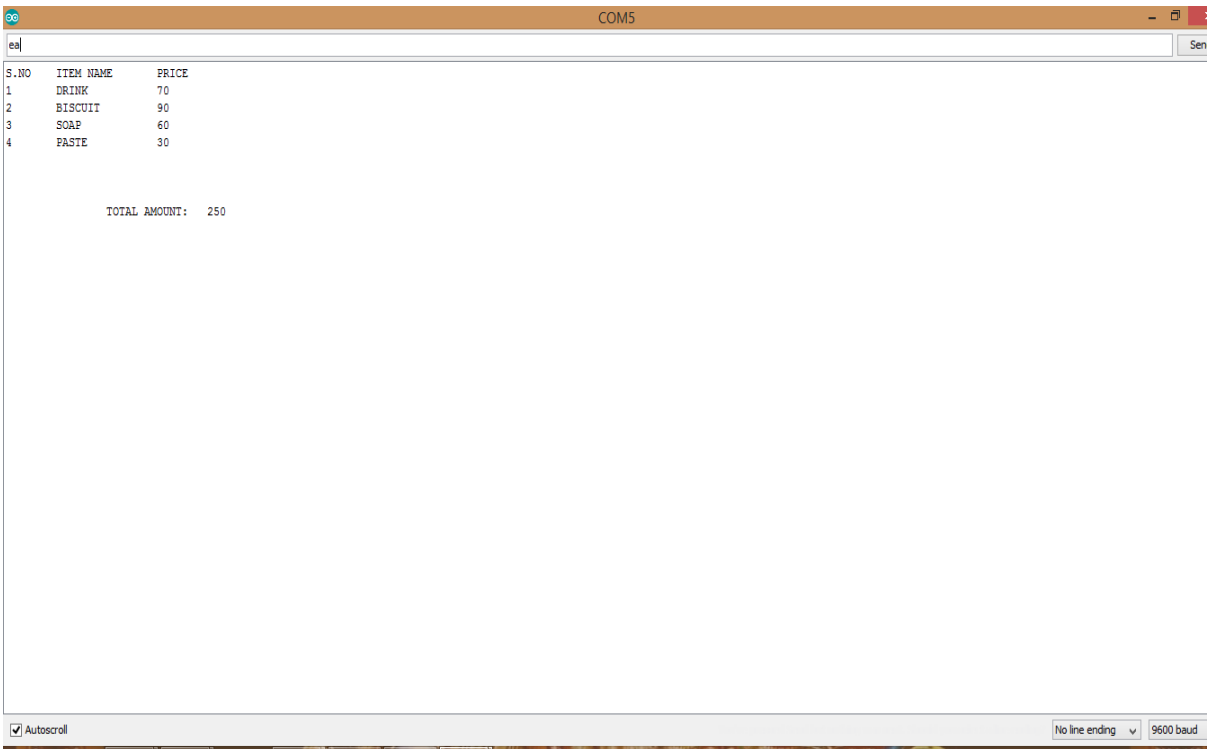

Figure 3.34 Display of Central Billing Unit

CHAPTER 4
IMPLEMENTATION AND RESULTS

Here as we are using raspberry pi3 as the main controller then for obvious reasons the software programming language will be Python. For raspberry pi, we can use software programming languages like C, C++ etc can be used but Python is friendly compared to other programming languages. The Python code can be seen in appendix .

The Complete system is implemented with the Raspberry pi connected with the peripherals RFID Reader and Zigbee Module to meet the requisite. The first step is to download and import the modules such as Tkinter for creating GUI(Graphical User Interface page) which gets displayed on the touch screen LCD, module time for assigning delays and another module tag which is declared as 'a' variable for handling different functions and module serial for serial communication of Reader and Zigbee Module. Here we assigned different variables such as ser1 for declaring zigbee serial communication with baud rate of 9600, items in an array, module tkinter Tk( ) as 'root' variable and then we assign that root in to labels with 'lab' variable which then is arranged into fixed pack sizes as lab.pack( ) for displaying on GUI page. Various functions such as ser1init( ) is defined for zigbee serial communication which initialises zigbee by making it active with ser1.open( ) and ser1.close() internally defined in it and clock( ) for refreshing tag data obtained by assigning data read from tags to 'b' variable and then configuring into labels and assigning to root with delay of 1000 seconds mentioned and refresh( ) for vanishing all tag data obtained by assigning 'time1' variable with display format such as SNO, Item name, Price and then assigning again that 'time1'variable into 'text' variable for configuring into labels and then assigning data in 'time1' variable into lab['text'] for putting into items array on display page. Finally we delete all the items in array ,this the logic performed in refresh( ) function and function send( ) for sending bill to Central billing unit through Zigbee module by assigning all tag data read into 'b' variable which is done already then printing data in 'b' variable with print(b) and writing that data to zibee module with ser1.write(b) functions written inside send( ) function. For writing data to zigbee module we need to initialise serial communication of zigbee with ser1init( ).And clock( ) function is written for continuous refreshing of data. Here buttons such as refresh and send are assigned with fixed sizes, positions in root which is nothing but tkinter to get displayed on the GUI page and root.mainloop( ) executes until application is closed.

Then after we import different modules such as read which contains tag data,serial for serial communication of Reader module ,time for assigning delays.Different variables are assigned such as 'ser' for declaring serial communicatin of Reader Module with port number and baud rate of 115200 and delay of 0.5 seconds. Functions such as serinit( ) is defined for serial communication with Reader Module which intialises by making it acitve with ser.close( ) and ser.open( ) and tagR( ) for initialising the working of reader by sending that internal defined commands to reader with delay of 0.01 seconds. In this tagRead( ) is defined which is used to read tags data by calling function tagR( ) which intialises Reader Working .It then waits for the tag data which after getting tag data stores in 'temp' variable in buffer and then splits data since we will get huge serial data by the reader for each tag. Initially we will flush the data using ser.flush( ) and then will start keeping the splitted data stored in 'temp' from buffer to 't' variable,then after splitting data stores in 'x' variable and we will assign 'r' variable for calculating length of splitted data using len(x).We will assign variable 'prod_id' for comparison of read tag data in the splitted data 'x' and products_id is the function which contains tag data kept in tag file.Then we will start comparing the splitted data with

each and every tag data kept in separate tag file. If read tag matches with any products_id then we will make its cart_id[prod_id]=1 which means product is in trolley. We will assign total amount as total and initialise to zero then after we take another variable 'id' for comparing data in ids function ,if cart_id[id]=1 then we will add the price of that respective product which is in trolley to total amount. Then if products are not there in items array then we will add that product to items array,or else we if len(item)>0 which means product is already in items array then we will remove that product from the items array to avoid the duplication of the products.We will assign variable 'res' to display the format on screen as SNO, ITEM NAME and PRICE. We will initialise the priceslist into an array,then we will take a variable 'item index' to compare with length of items. With id we will compare with the products in products_id,if id is matched then will we add price of that specific product in the items array. We use another variable 'ind' to compare with length of items,then we will add to the string to get updated 'res'and total amount to be displayed on screen. We will assign a delay of 0.5 seconds and we will make it to return the 'res'. Then after initialising the serial communication with the reader module takes place using serinit( ) for reading of tags.

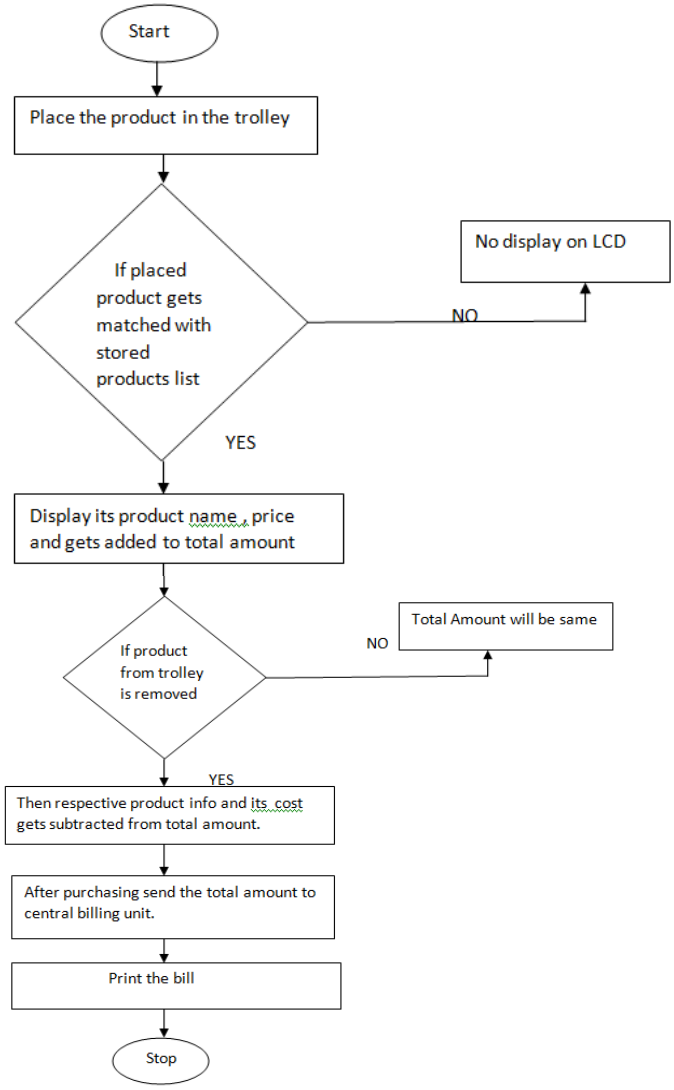

Figure 4.1 Flow diagram for code

Figure 4.1 is the flow chart for the code of the proposed system. It works as if the products are added to the trolley then its cost and name gets displayed on the screen by adding to total amount simultaneously. While adding to the screen it checks whether product is already in the item array or not ,if already present in the item array it ignores adding of product to avoid duplication or else if not there then it adds to the item array. If product is removed from the trolley then cost of respective product and info gets deleted from total amount .After purchasing when the custoer arrives at the billing counter he sends the total bill to the Central Billing unit through the Zigbee Modules.

Figure 4.2 shows how products get display on screen of LCD

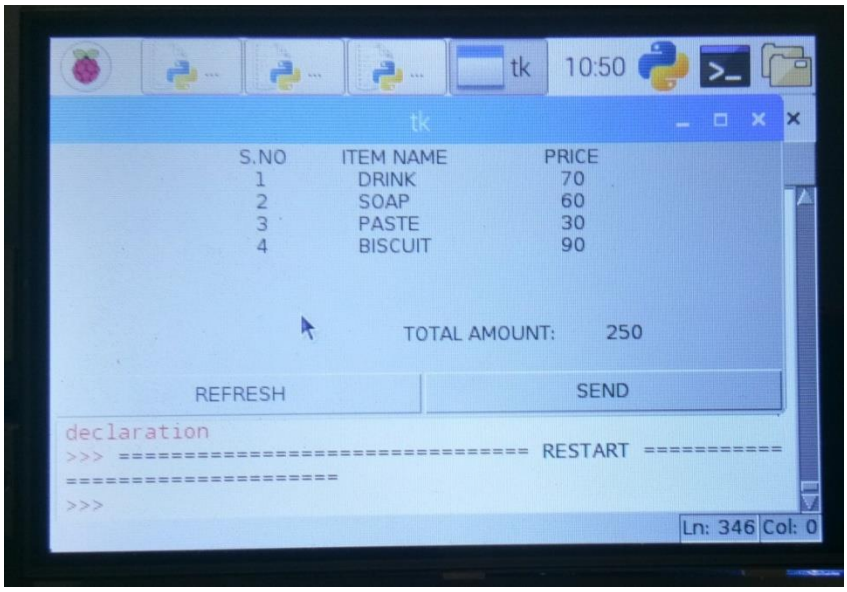

Figure 4.2 Display of products list on LCD

Figure 4.3 shows the display of products in Central billing unit .

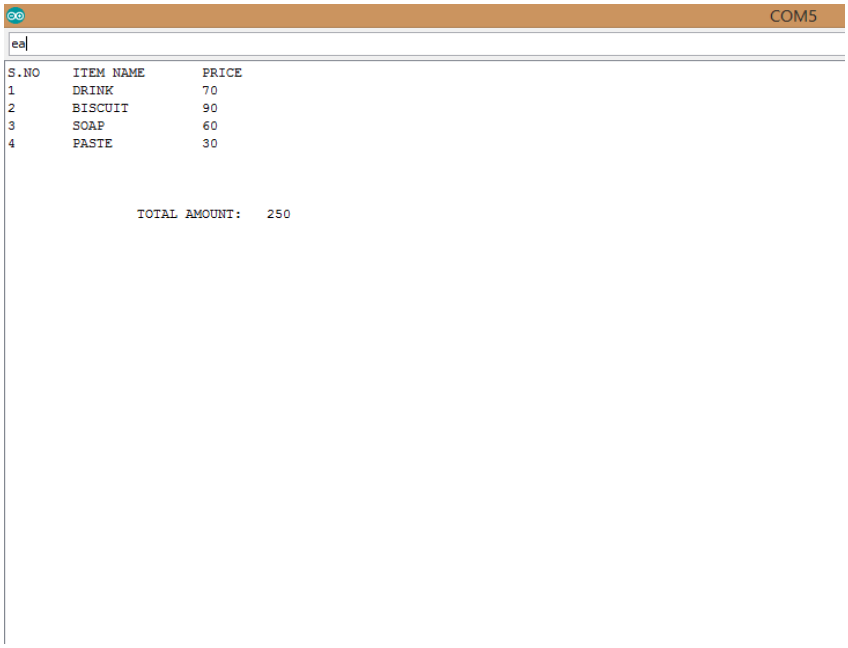

Figure 4.3 Display of products list on Central Billing unit

Figure 4.4 details display on screen how if one product for example drink is removed from trolley.

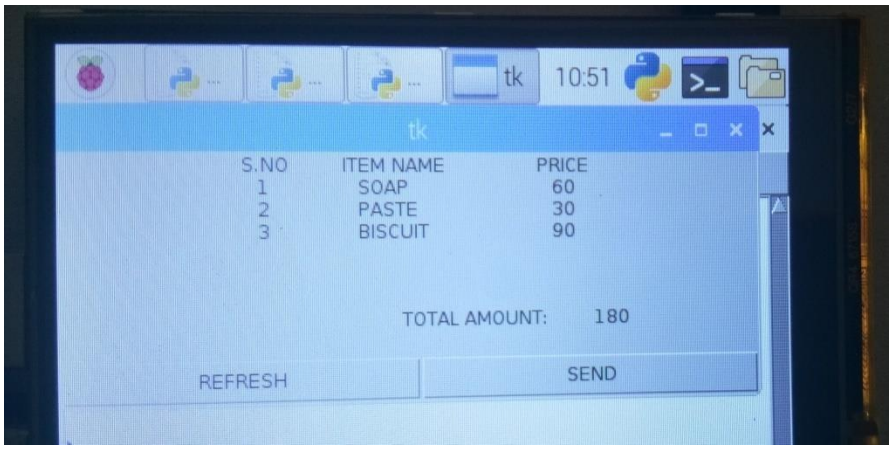

Figure 4.4 Removal of single product data on LCD

Figure 4.5 shows the updated amount in the Central billing unit if one product is removed.

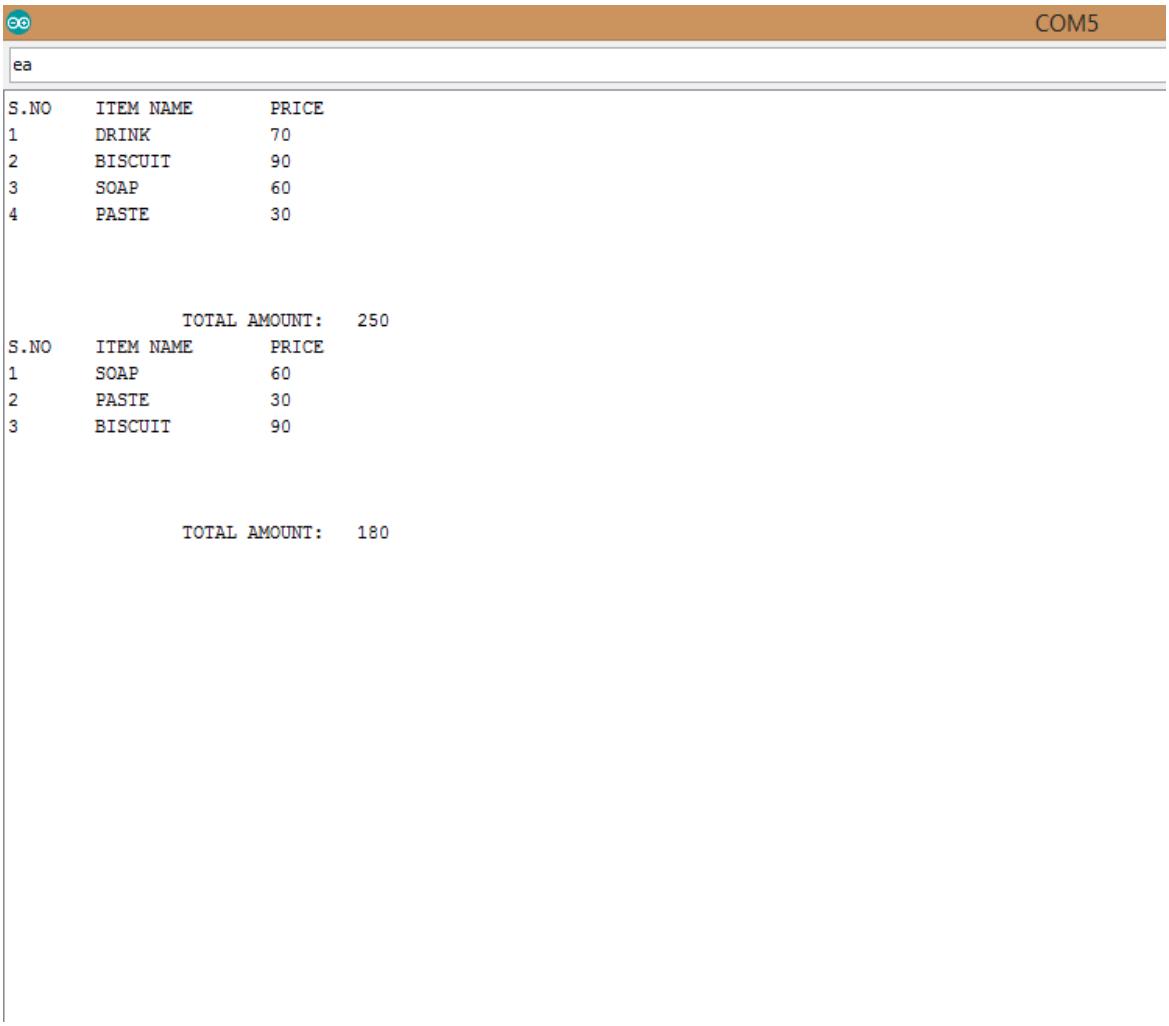

Figure 4.5 Removal of single product data on Central Billing unit

Figure 4.6 shows how data is displayed on screen if another product for example paste is removed from trolley.

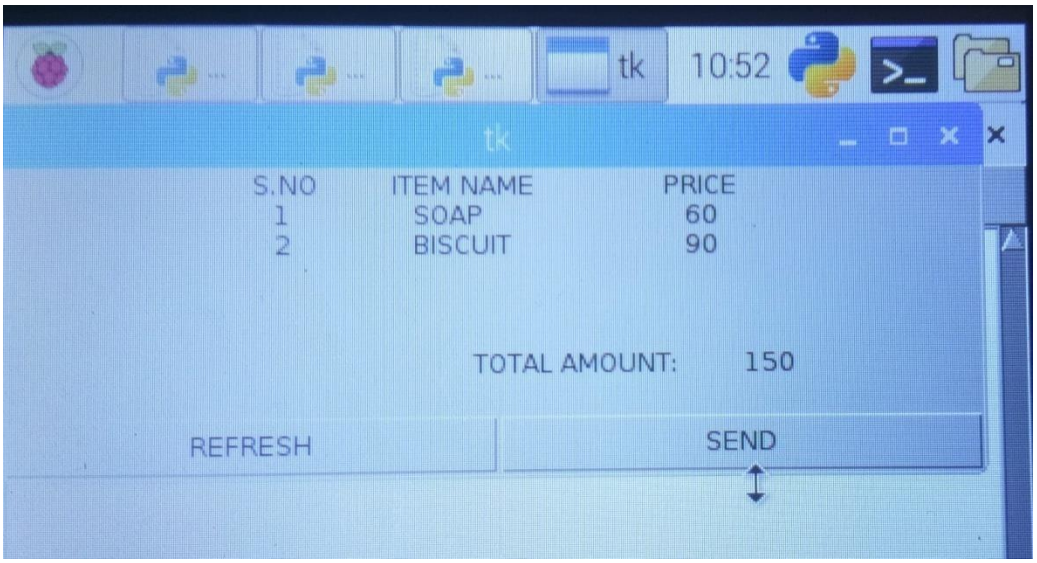

Figure 4.6 Updated products list on LCD

Figure 4.7 details the display of updated information in Central Billing unit.

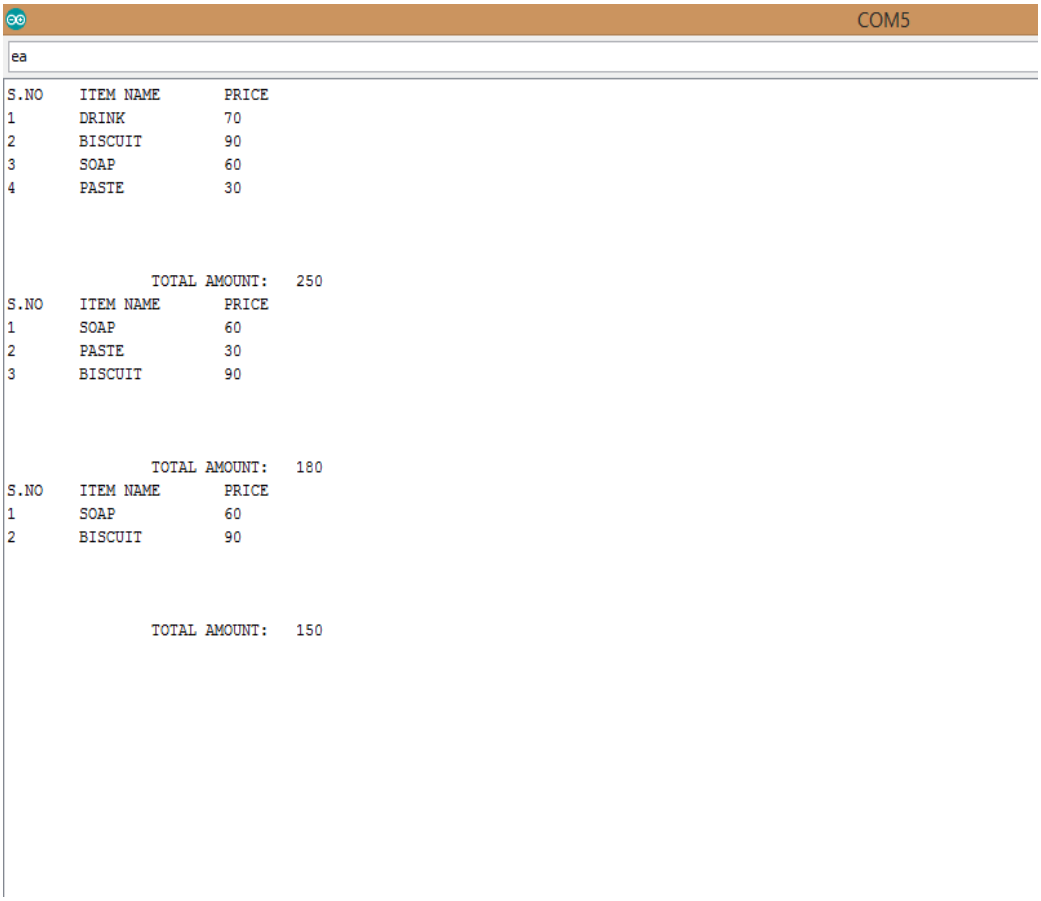

Figure 4.7 Updated products list on Central Billing unit

Figure 4.8 shows the display on screen if another product for example biscuit is removed from the trolley.

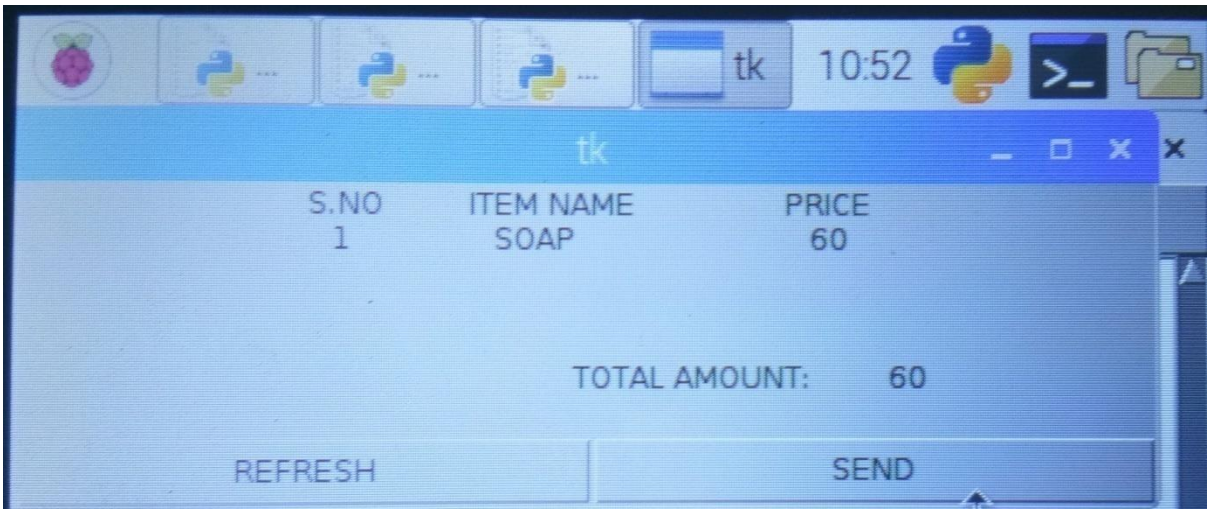

Figure 4.8 Single product data on LCD

Figure 4.9 shows the display of updated information in Central Billing unit .

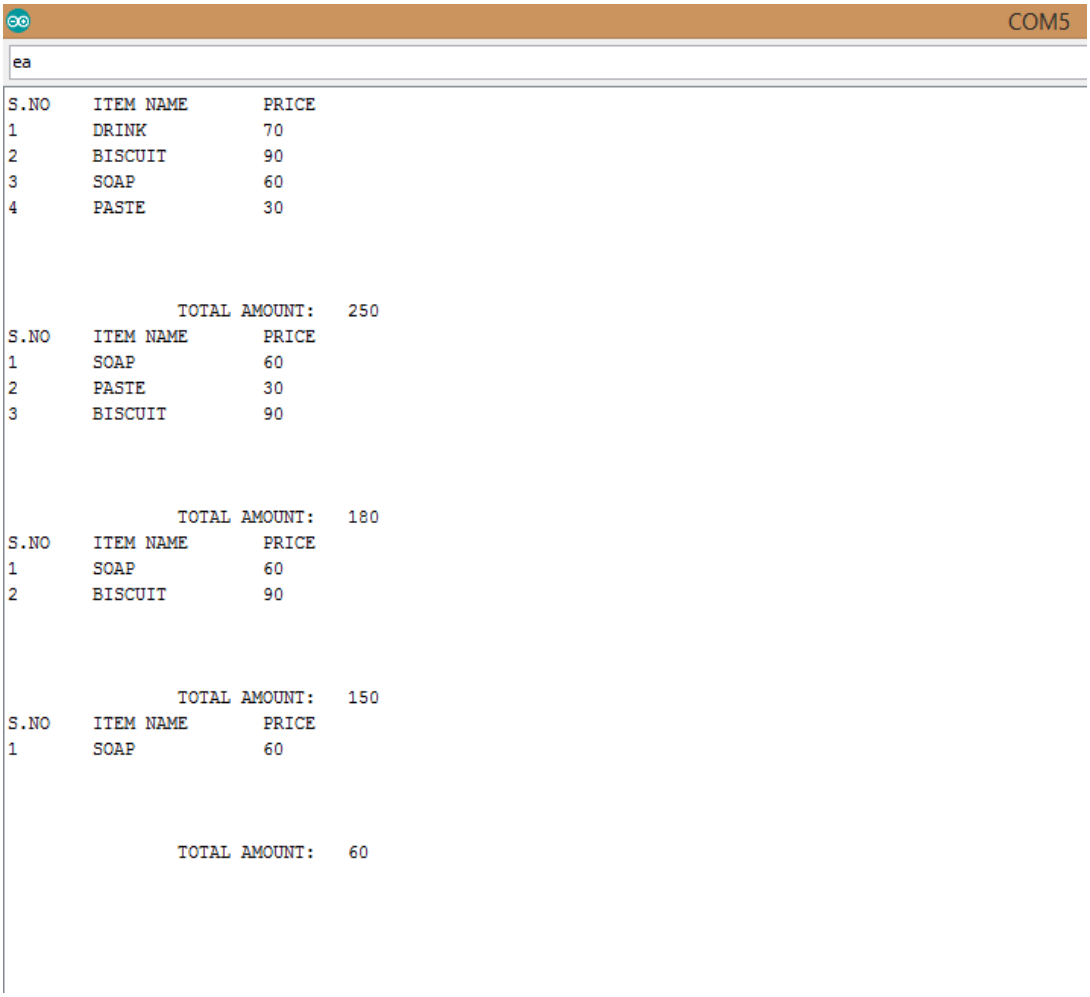

Figure 4.9 Single product data on Central Billing unit

Figure 4.10 shows the display on screen how if all products are removed from the trolley.

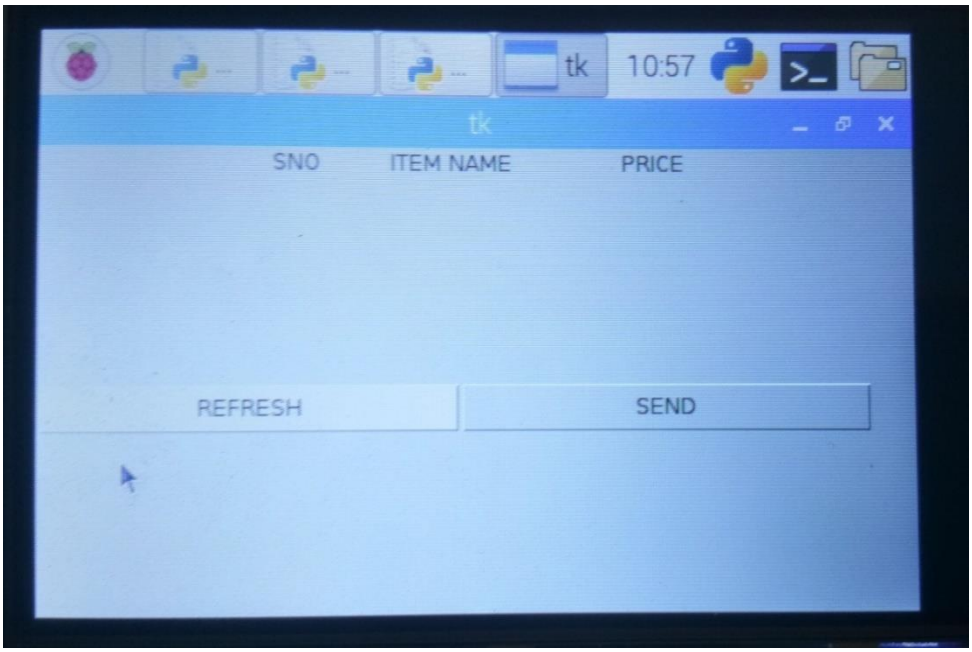

Figure 4.10 No product data on LCD

4.1 Experimental Results

Testing of the system with various products

The project is evaluated with different trial cases for every 1cm with three distinct items assessed for all the practical trials inside the trolley of length 60 cms with the reader keeping at center position in the trolley. Rate of detection also depends on the material of the product with which the tag is attached.

Figure 4.11 shows how detection rate of reader changes with flexible plastic products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. This products contain very low thickness based packaging so there is constant detection rate for almost all the distance except at few points.

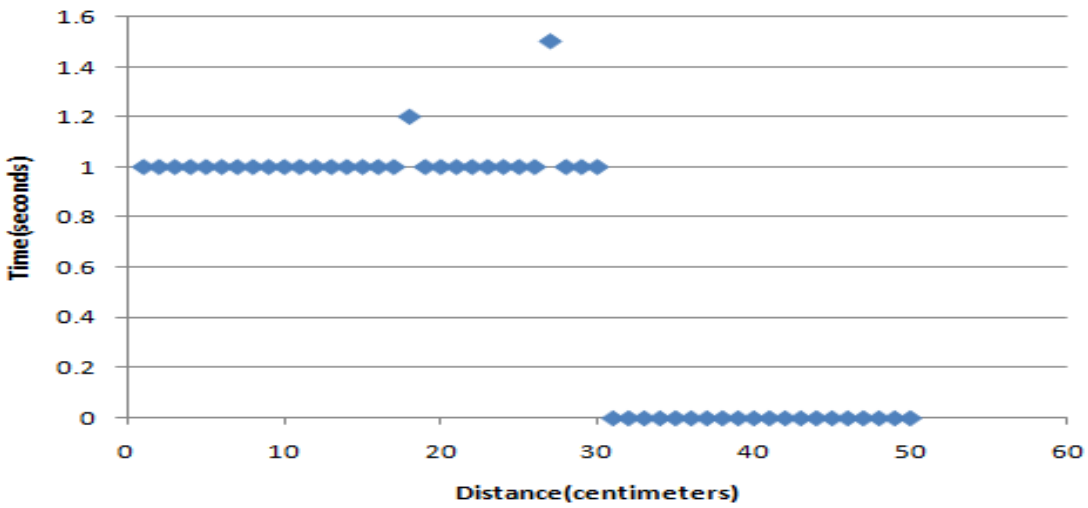

Figure 4.11 Detection rate for flexible plastic products in the trolley

Figure 4.12 shows how detection rate of reader changes with removal of flexible plastic products from the trolley. The x axis corresponds to distance and y axis corresponds to time. There is no consistency in the removal rate of first tag and second tag but the third tag is showing constant removal rate.

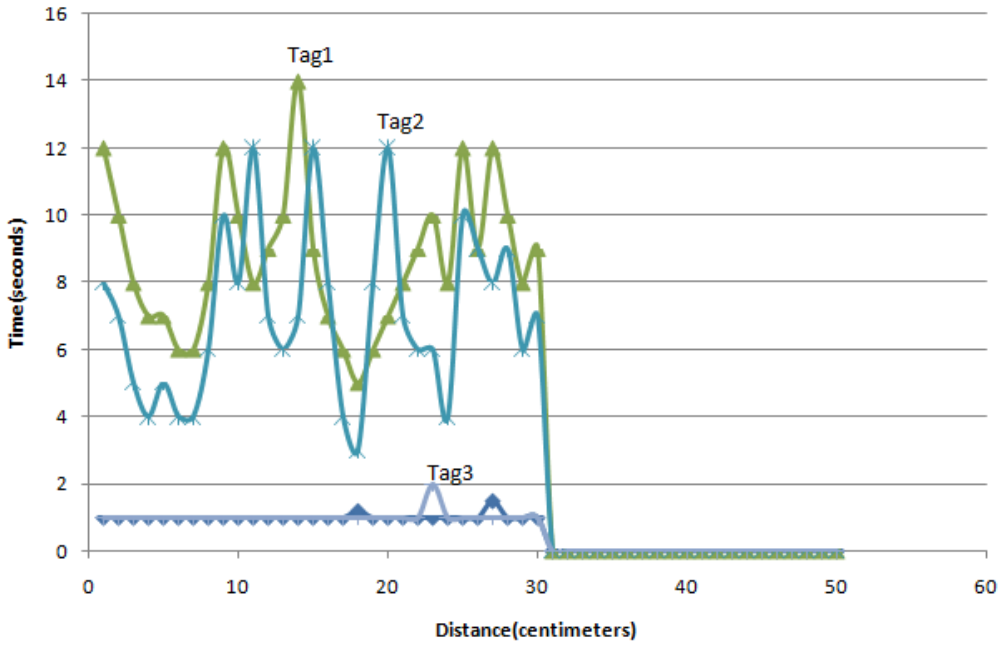

Figure 4.12 Detection rate for removal of flexible plastic products from the trolley

Figure 4.13 shows how detection rate of reader changes with distance for rigid plastic products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. Rigid plastic products are made up of HDPE, LDPE plastic which have good rigidity and so detection rate was constant till some distance and has been fluctuating continuously.

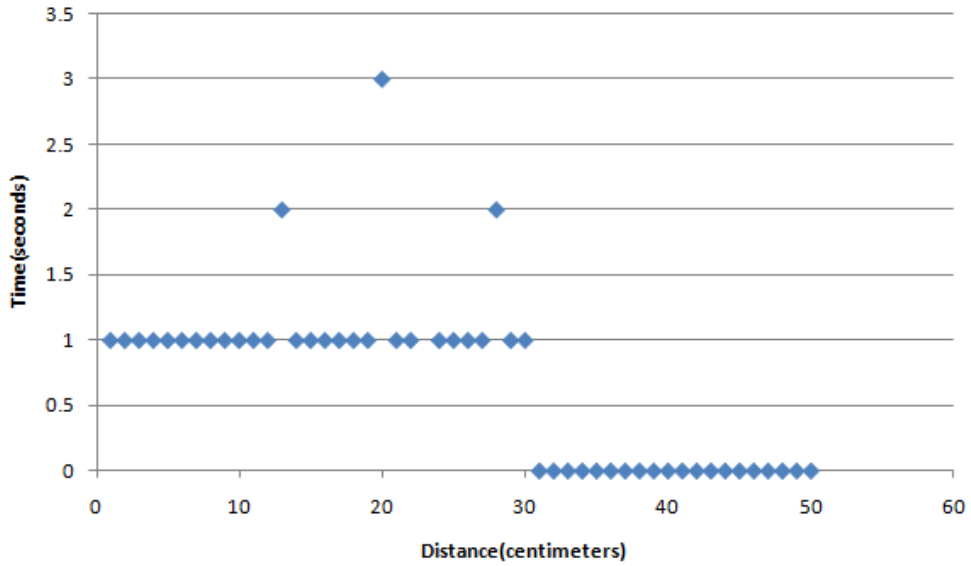

Figure 4.13 Detection rate for rigid plastic products in the trolley

Figure 4.14 details how the detection rate of reader changes with distance for removal of rigid plastic products from the trolley. The x axis corresponds to distance and y axis corresponds to time. Removal rate for first tag is changing steadily where as removal rate for second tag is lower when compared to first tag while the third tag is showing constant removal rate.

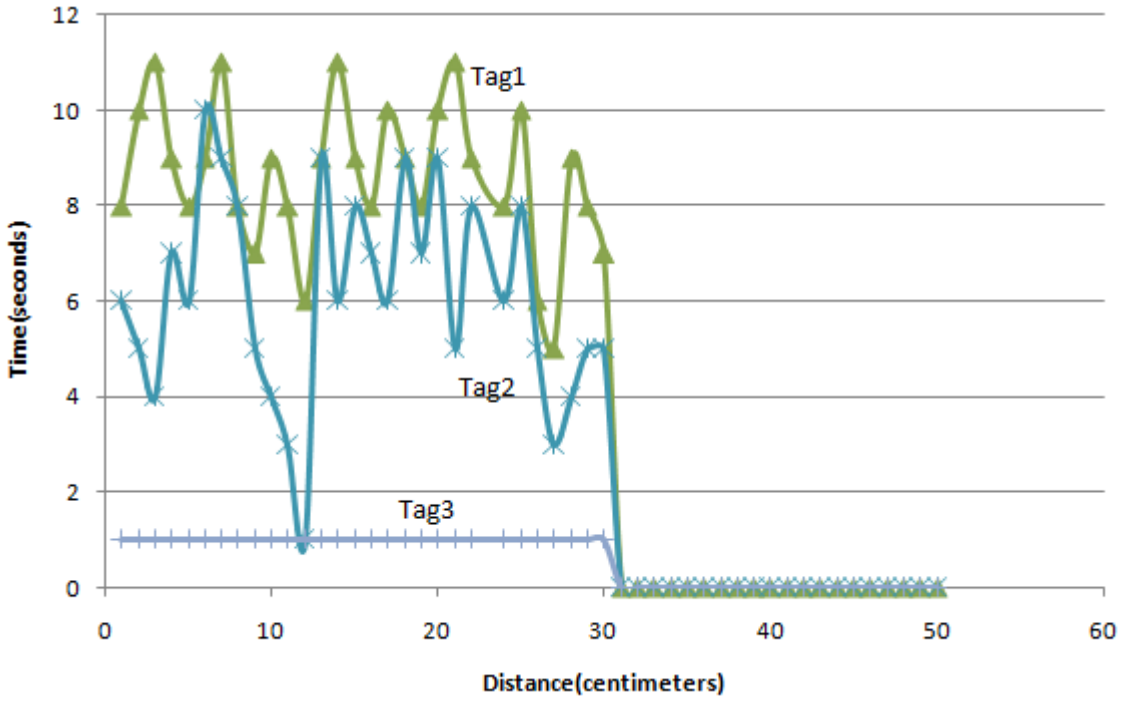

Figure 4.14 Detection rate for removal of rigid plastic products from the trolley

Figure 4.15 details how the detection rate of reader changes with distance for tin free steel products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. This products contain very less percent of steel with chromium in its packaging and this is because rate of detection is changing with distance at few points.

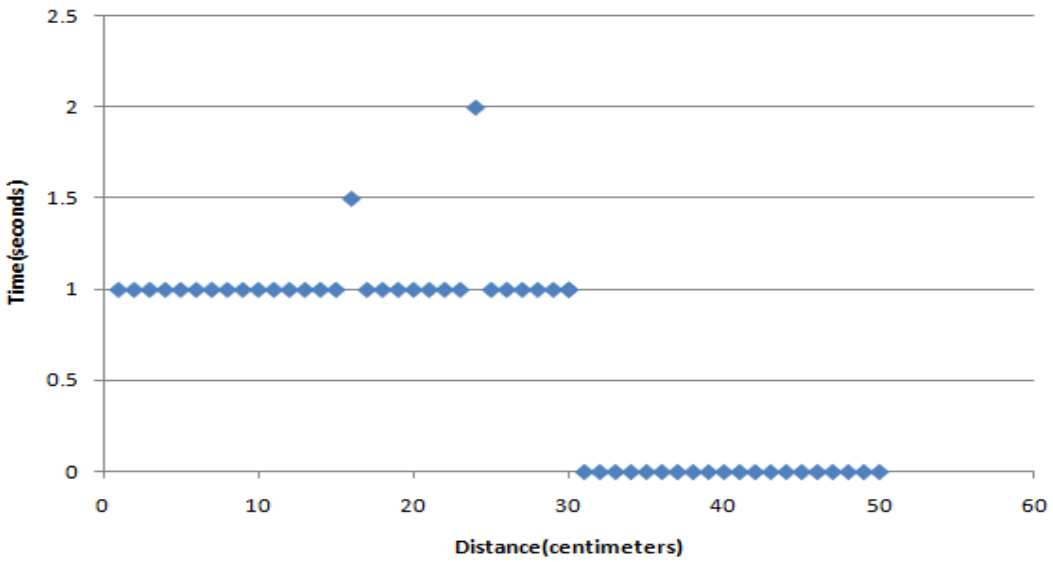

Figure 4.15 Detection rate for tin free steel products in the trolley

Figure 4.16 details how the detection rate of reader changes with distance for removal of tin free steel products from the trolley. The x axis corresponds to distance and y axis corresponds to time. The first and second tags removal is changing constantly where as the third tag removal rate is constant .

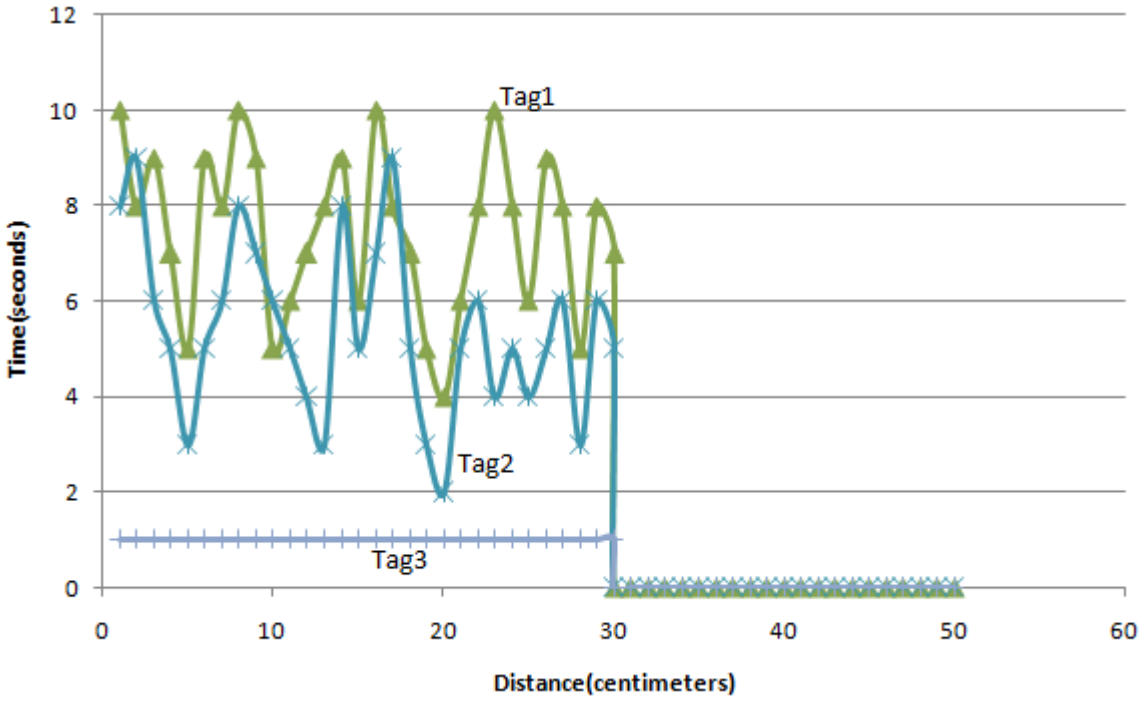

Figure 4.16 Detection rate for removal of tin free steel products from the trolley

Figure 4.17 shows the detection rate of reader changes with distance for glass products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. Glass products contain silicates of sodium and calcium in its packaging and so detection rate is increasing steadily and becoming constant again .

.

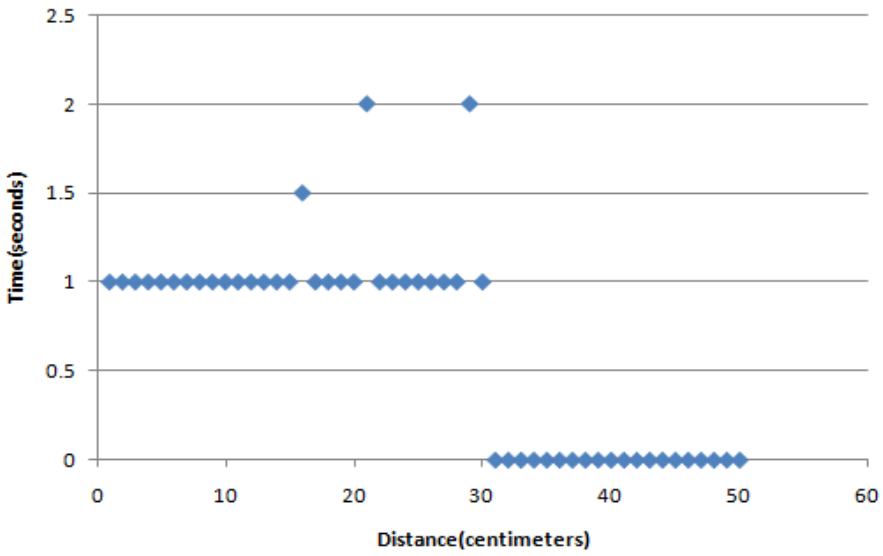

Figure 4.17 Detection rate for glass products in the trolley

Figure 4.18 shows the detection rate of of reader changes with distance for removal of glass products from the trolley. The x axis corresponds to distance and y axis corresponds to time. The first tag and second tags removal rates are changing with distance while the third tag is showing steady removal rate.

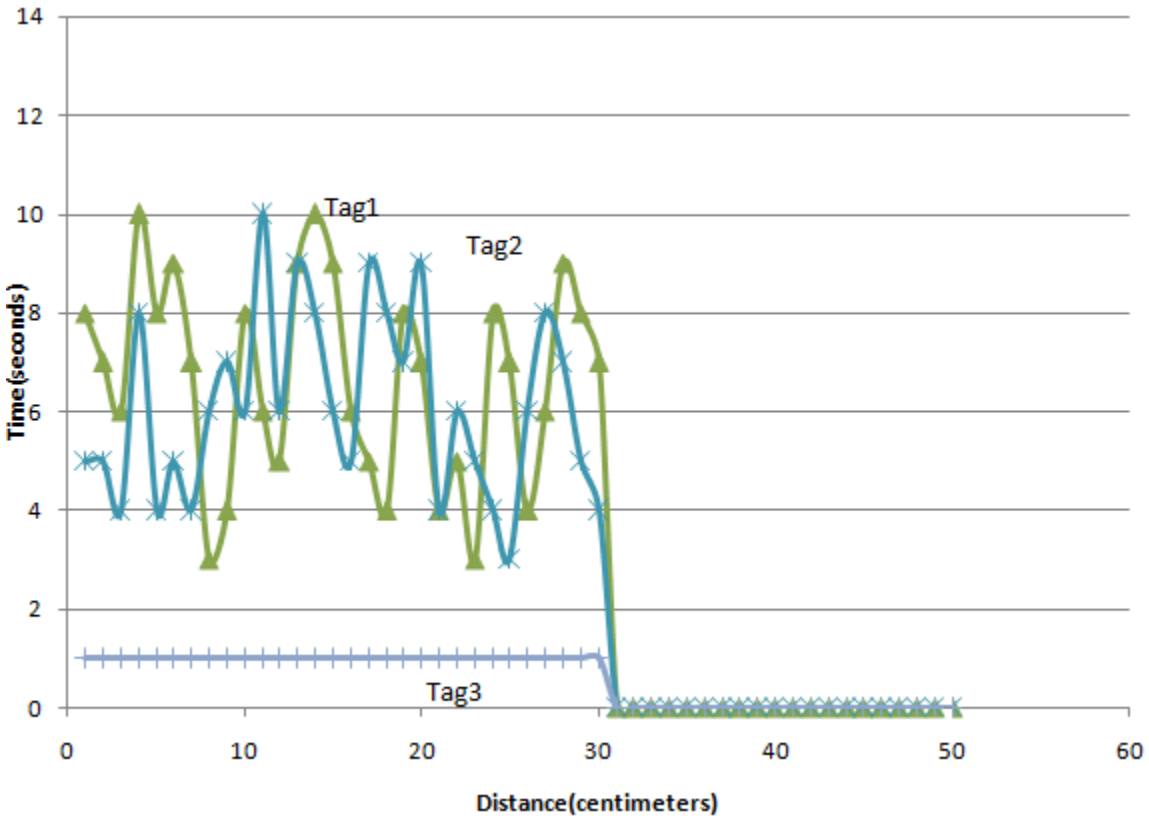

Figure 4.18 Detection rate for removal of glass products from the trolley

Figure 4.19 shows how the detection rate of reader changes with distance for paper and cardboard products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. Paper and cardboard containers contain paper based packaging ,so the detection rate will be almost constant .

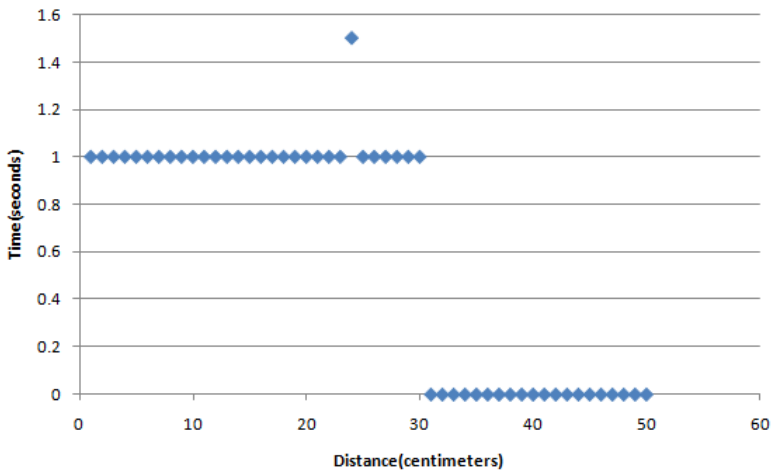

Figure 4.19 Detection rate for paper and cardboard products in the trolley

Figure 4.20 shows how the detection rate of reader changes with distance for removal of paper and cardboard products from the trolley. The x axis corresponds to distance and yaxis corresponds to time. Rate of detection is inconsistent and was changing as distance increases. First tag removal rate is fluctuating and the second tag is following the removal rate of second tag,where as third tag removal rate is constant.

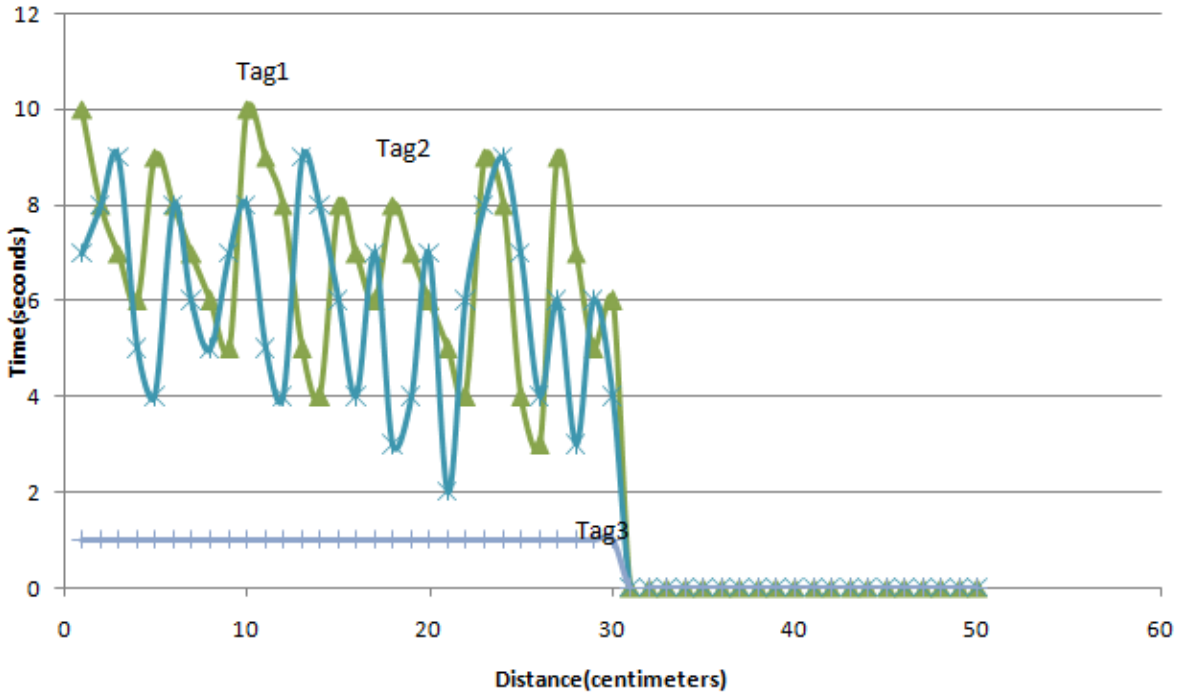

Figure 4.20 Detection rate for removal of paper and cardboard products from trolley

Figure 4.21 shows how the detection rate of reader changes with distance for aluminium products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. Aluminum is a good metal which can't get detected in our trolley since the tags which we used are metal sensitive. So there will be no detection rate for these products except at few points.

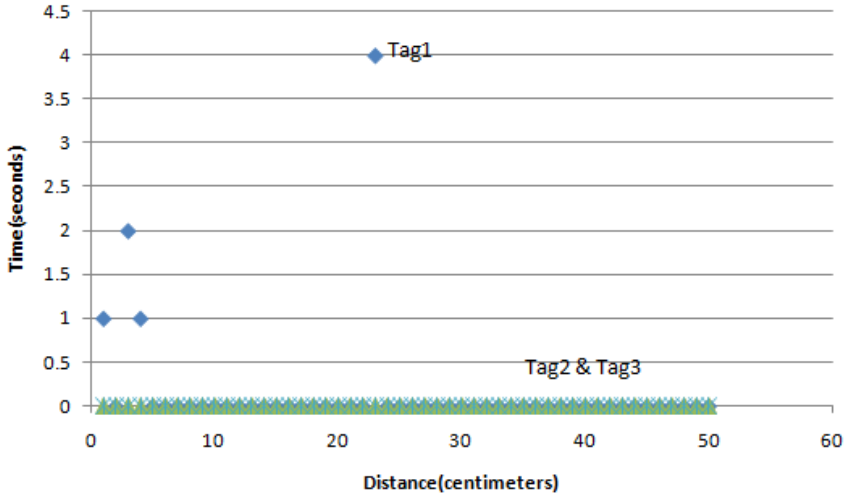

Figure 4.21 Detection rate for aluminium products in the trolley

Figure 4.22 shows how the detection rate of reader changes with distance for removal of aluminium products from the trolley. The x axis corresponds to distance and yaxis corresponds to time. Since the products are not getting detected there will be obviously no detection rate for removal rate for aluminium products from the trolley.

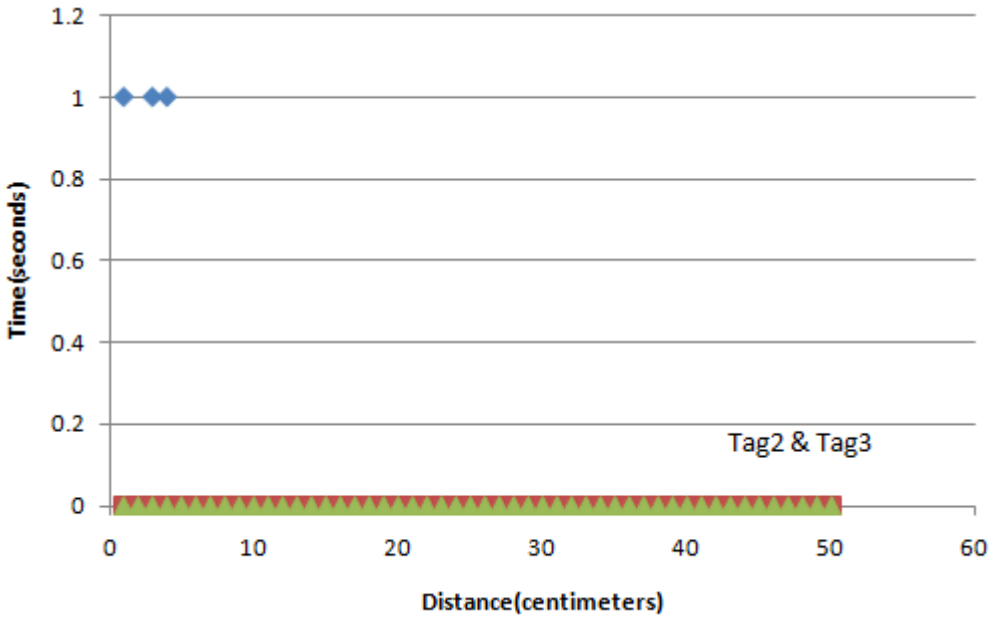

Figure 4.22 Detection rate for removal of aluminium products from the trolley

Figure 4.23 shows how the detection rate of reader changes with distance for tin plate products inside the trolley. The x axis corresponds to distance and y axis corresponds to time. Tin is a metal which can't get detected in our trolley since the tags which we used are metal sensitive. So there will be no detection except at short range from reader.

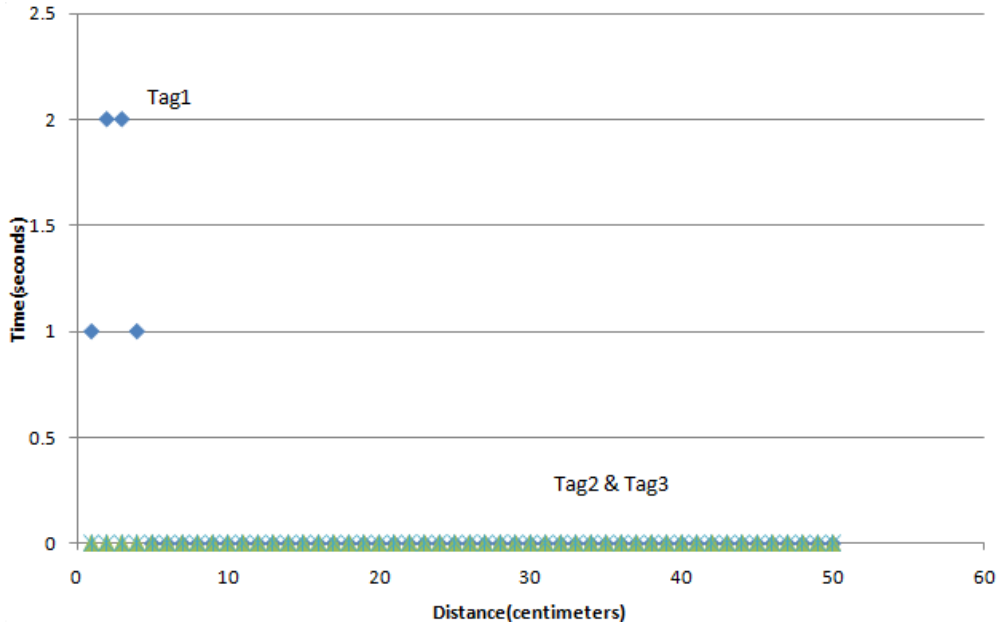

Figure 4.23 Detection rate for tin plate products in the trolley

Figure 4.24 shows how the detection rate of reader changes with distance for removal of tin plate products from the trolley. The x axis corresponds to distance and y axis corresponds to time. Since the products are not getting detected there will be obviously no detection rate for removal rate for aluminium products from the trolley.

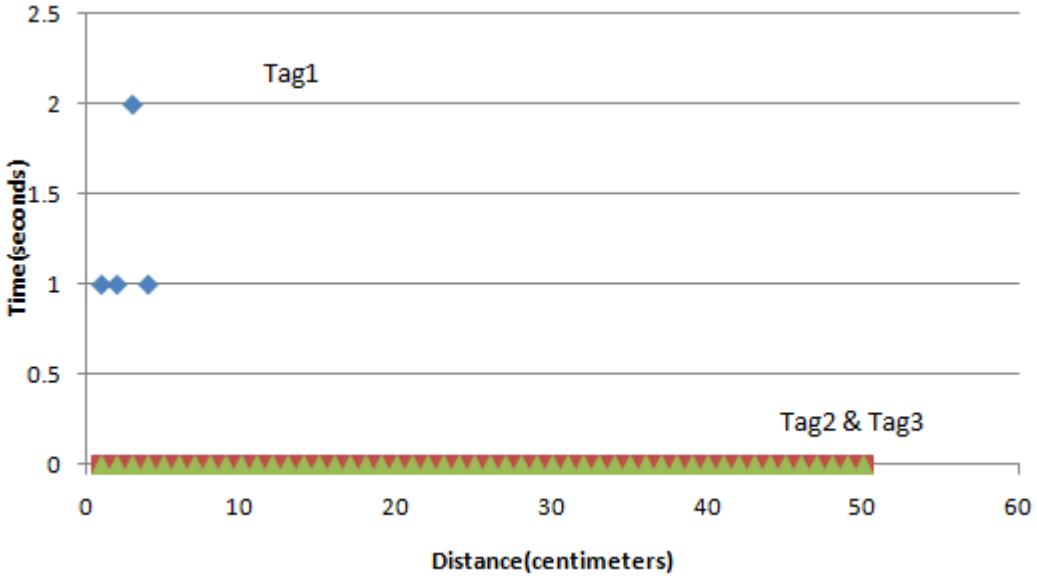

Figure 4.24 Detection rate for removal of tin plate products from the trolley

4.2 System Accuracy

The accuracy of this detection is calculated by forming a confusion matrix. Confusion

matrix has four main parameters

1) TP = True Positives,

2) FN = False Negatives,

3) FP= False Positives

4) TN= True Negatives

and according to this case they can be defined as:

TP (True Positive) : In this case it is the predicted yes (tag predicted) and it is a tag.

TN (True Negative) : In this case it is predicted no and there is no tag

FP (False Positive) : Predicted yes, but actually there is no tag.

FN (False Negative) : Predicted no , but actually there is a tag.

In this experiment, a total of 10 trials were done on different types of products at from different distances in the trolley and checked if detected or not ,the results are obtained as follows:

Table 4.1 shows the Reader detection accuracy which is calculated by preserving the number of miss-predictions obtained to calculate the precision and recall value from the confusion matrix.

Tabel 4.1 Accuracy of the system

True Positives	5
False Positives	1
True Negatives	3
False Negatives	1
Confusion Matrix: $\begin{vmatrix} TP & FN \\ FP & TN \end{vmatrix}$	**Confusion Matrix:** $\begin{vmatrix} 5 & 1 \\ 1 & 3 \end{vmatrix}$
Precision: $\frac{TP}{TP+FP}$	**Precision:** 83%
Recall: $\frac{TP}{TP+FN}$	**Recall:** 83%
F1(Accuracy) $2 \times \frac{precision\ x\ recall}{precision+recall}$	**F1(Accuracy)** 83 %

With these calculations , the system accuracy for detection of tags inside the trolley is 83%.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 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 more 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 inorder 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.

5.2 Recommendations

Based upon the research , recommendations proposed for the further study are as follows:

- It can also be extended by using more powerful RFID readers with enhanced capacity incase of more number of products in the trolley.
- Water sensitive and more powerful tags with more advanced features like metal resistant and temperature resistant are under research which will be very useful in future.

REFERENCES

[1] Suraj.S, Vishal Guruprasad, Udayagiri R Pranava, Preetham S Nag, "RFID Based Wireless Intelligent Cart Using ARM7," *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 5, Issue 8, 2016.

[2] Suryaprasad J, Praveen Kumar B O, Roopa D & Arjun A K, " A Novel Low-Cost Intelligent Shopping Cart," *IEEE, 2014.*

[3] Komal Ambekar, Vinayak Dhole, Supriya Sharma,"Smart Shopping Trolley Using RFID," *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)*, Volume 4 Issue 10, 2015.

[4] K.Gogila Devi, T.A.Kaarthik, N.Kalai Selvi, K.Nandhini, S.Priya, "Smart Shopping Trolley Using RFID Based on IoT," *International Journal of Innovative Research in Computer and Communication Engineering*. Vol. 5, Issue 3, 2017.

[5] Amine Karmouche, Yassine Salih-Alj, "Aisle-level Scanning for Pervasive RFID based Shopping Applications *," IEEE.*

[6] Satish Kamble, Sachin Meshram, Rahul Thokal & Roshan Gakre, "Developing a Multitasking Shopping Trolley based on RFID Technology," *International Journal of Soft Computing and Engineering (IJSCE),* ISSN: 2231-2307, Volume-3, Issue-6, 2014.

[7] Chandrasekar.P , Ms. T. Sangeetha, " Smart Shopping Cart with Automatic Central Billing System through RFID and ZigBee," *IEEE, 2014.*

[8] Galande Jayshree, Rutuja Gholap, Preeti Yadav, " RFID Based Automatic Billing Trolley,"*InternationalJournal of Emerging Technology & AdvancedEngineering 2014.*

[9] BarCode Scanning , October 25, 2017. [Online]. Available at http://www.scholarpedia.org/article/Bar_code_scanning . Scholarpedia, 7(9):12215.

[10] Paxal Shah, Ms. Jasmine Jha, Nirav Khetra, Manmitsinh Zala "A Literature Review Improving Error Accuracy and Range based on RFID for Smart Shopping," *International Journal for Scientific Research & Development(IJSRD),2015.*

[11] Lynn A. DeNoia , Anne L. Olsen , "RFID and Application Security,"*Journal of Research and Practice in Information Technology*, Vol. 41, No. 3, 2009.

[12] Mayur Subhash Chaudhari, "A Review on Electronic Shopping Cart Based RFID," *International Journal & Magazine of Engineering, Technology Management & Research,* ISSN No: 2348-4845.

[13] Murari Kumar, Rachana, Shomya Dwivedi , Saurav Sharma and Shivani Joshi, "SMART BASKET DESIGN USING ARDUINO AND RFID MODULE," *International Journal of Recent Scientific Research Research* Vol. 8, Issue, 3, pp. 2017.

[14] Lekshmy S, Ms.Aniltta T C, Ms.Nivya Shaji, "RFID BASED SHOPPING TROLLEY," *International Journal of Computer Engineering In Research Trends,* Volume 2, Issue 12, 2015.

[15] Raju Kumar, K. Gopalakrishna, K. Ramesha, "Intelligent Shopping Cart," *International Journal of Engineering Science and Innovative Technology (IJESIT),2013.*

[16] High Temperature RFID Tags, RFID Metal Tags August 9, 2017[Online]. Available: http://www.uskoreahotlink.com/products/detectors/high-temperature-rfid-tags

[17] KalyaniDawkhar,ShraddhaDhomase,SamruddhiMahabaleshwarkar , " Electronic Shopping Cart For Effective Shopping based on RFID," *International Journal of Innovative Research in Electrical , Electronics , Instrumentation And Control Engineering,* Vol. 5, Issue 5, May 2017 .

[18] Ankush Yewatkara , Faiz Inamdarb , Raj Singhc , Ayushyad , Amol Bandale , "Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID & Zigbee with Anti-Theft," 7th International Conference on Communication, Computing and Virtualization , 2016.

[19] VarshaJalkote , Alay Patel, VijayaGawande, Manish Bharadia, Gitanjali R. Shinde, Aaradhana A Deshmukh, "Futuristic Trolley for Intelligent Billing with Amalgamation of RFID and ZIGBEE",*International Journal of Computer Applications. International Conference on Recent Trends in engineering & Technology ,2013.*

[20] Yathisha , Abhishek , Harshith , Darshan Koundinya & Srinidhi K, "Automation of Shopping Cart to Ease Queue in Malls by using RFID," *International Research Journal of Engineering and Technology (IRJET),2015.*

[21] Zeeshan Ali, Reena Sonkusare , " RFID Based Smart Shopping and Billing ," *International Journal of Advanced Research in Computer and Communication Engineering* ,Volume 4, Issue 3, 2013.

APPENDIX

```
from Tkinter import *
import time
import tag as a
import serial
ser1=serial.Serial("/dev/ttyUSB1",9600,timeout=0.5)
item=[]
root = Tk()
lab = Label(root)
lab.pack()
def ser1init():
        ser1.close()
        ser1.open()
        #print 'SERIAL 1 OK'
def clock():
    b=a.tagRead()
    lab.config(text=b)
    root.after(1000, clock)
def refresh():
    time1="SNO"+"\t"+"ITEM NAME"+"\t"+"PRICE"+"\n"
    lab.config(text=time1)
    lab['text'] = time1
    del item[:]
def send():
    print "SENDING BILL"
    b=a.tagRead()
    print(b)
    ser1.write(b)
ser1init()
refresh()
clock()
button = Button(root, text='REFRESH', width=25, command=refresh)
button.pack(side=LEFT)
button = Button(root, text='SEND', width=25, command=send)
button.pack(side=LEFT)
root.mainloop()
```

```
from read import *
import serial
import time
ser=serial.Serial("/dev/tty/USB0",115200,timeout=0.5)
item=[]
def serinit():
         ser.close()
         ser.open()
         #print 'SERIAL OK'
def tagR():
    ser.write(chr(0xA0))
    ser.write(chr(0x04))
    ser.write(chr(0x01))
    ser.write(chr(0x89))
    ser.write(chr(0x01))
    ser.write(chr(0xD1))
    ser.write(chr(0x00))
    time.sleep(0.01)

def tagRead():
    while True:
        tagR()
        if(ser.inWaiting()):
            temp=ser.readline().split()
            ser.flush()
            t=str(temp)
            x=t.split("\\")
            r=len(x)
            for prod_id in x:
                if prod_id in products_id:
                    cart_id[prod_id] = "1"

 total = 0
 for id in ids:
     if str(cart_id[id]) == "1":
         total = total + int(prices_id[id])

         if not products_id[id] in item:
             item.append(products_id[id])
     else:
         if len(item) > 0:
             if products_id[id] in item:
                 item.remove(products_id[id])
```

```
            res="S.NO"+"\t"+"ITEM NAME"+"\t"+"PRICE"+"\n"

            price = ""
            price_list = []
            for item_index in range(0, len(item)):
                for id, product in products_id.iteritems():
                    if product == item[item_index]:
                        price_list.append(prices_id[id])

            for ind in range(0, len(item)):
                res += str(ind + 1) + "\t" +item[ind] + "\t\t"+ price_list[ind] +"\n"

            res+="\n\n\n"+"\t\tTOTAL AMOUNT:"+"\t"+str(total)+"\n"
            time.sleep(0.5)
            return(res)

serinit()
```

```
ids = ['x05~', 'x0~@', 'x19`K', 'x00P', 'x000']

products_id = {'x05~': 'BRUSH',
               'x0~@': 'SOAP',
               'x19`K': 'BISCUIT',
               'x00P': 'PASTE',
               'x000': 'DRINK'}

cart_id = {'x05~': '0',
           'x0~@': '0',
           'x19`K': '0',
           'x00P': '0',
           'x000': '0'}

prices_id = {'x05~': '50',
             'x0~@': '49',
             'x19`K': '90',
             'x00P': '30',
             'x000': '70'}
```