Smart Cart

[1]Dr. Doreen Hephzibah Miriam [2]Shambhavi Sivan [3]Arthi.K [4]Shanmathi.R
[1]Professor [2,3,4]U.G student
[1,2,3,4]Department of Information Technology
[1,2,3,4]Loyola-ICAM College of Engineering and Technology, Chennai

Abstract

Recent trends use Radio Frequency Identification (RFID) technology in day to day life. They are the ubiquitous tool available for monitoring any item in various fields. RFID technique is mainly used for the security, tracking and monitoring purposes in the tollgate transactions, bank locker security system, automatic vehicle speed control and library books security system. The communication using RFID is in the wireless manner and does not require line of sight. Application of RFID results in automation of huge and complex systems. One of the interesting applications of RFID is an automated shopping cart. Now-a-days, the billing process is highly time consuming and has created the need for shops to employ more human resource in the billing section, but yet, the waiting time remains considerably high. Hence, we propose the "Automated Shopping Cart" as a solution to the above problems. The "Automated Shopping Cart" is simply a trolley or a hand – held cart at a store, which has fixed in it an RFID reader that interacts with an Arduino UNO Controller. RFID tags are attached to every product available for sale at the store. As items are added into the cart, they are detected by the reader and their prices are summed up incrementally. On completion of the purchase and reaching the billing point, the calculated total amount for the respective customer can be transferred wirelessly to the cashier's PC for bill generation and subsequent payment of the bill. A copy of the same is sent via an SMS to the customer's mobile using GSM. This system is expected to speed up all the transactions, improve business for the shopping stores as well as ease up and cut down the time of the entire shopping process for the customers, especially in today's fast moving busy world.

Keyword- RFID – Radio Frequency Identification; PC – Personal Computer; SMS – Short Message Service; GSM – Global System for Mobile communication

---

I. INTRODUCTION

The Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source such as a battery and may operate at hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method for Automatic Identification and Data Capture (AIDC).

RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions and other is an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively. An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

One of the technologies used to implement RFID is Arduino programming. Arduino is an open-source hardware. An Arduino board consists of an Atmel 8-, 16- or 32-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560). The boards use single-row pins to facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple, and possibly stacked shields may be individually addressable via an I²C (Inner Integrated Circuit) serial bus. Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default boot loader of the Arduino UNO is the option boot loader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB). The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. Here, we use Arduino microcontroller to store information about the products and code to correctly identify an item.

RFID can be put to practice in a wide range of simple yet unusual applications as described below. In Amusement Parks, RFID technology is integrated into the tickets. The credit-card style tickets eliminate the need for scanning and swiping in ride lines, reducing wait times and lowering staffing costs. Additionally, the RFID-enabled tickets provide park operators a rich source of information for tracking the movement of thrill-seekers throughout the grounds. As far as fashion is concerned, we have Smart fitting rooms, where retailers outfitting dressing rooms with interactive, RFID powered kiosks. By scanning dressing room items,

shoppers can access product data, find similar alternatives, and provide feedback. Robbery-Proof Chips at casinos, can log how much you spend, where you spend it, and use that information to keep you in the game longer with well-timed drinks and services catered to your activity. If you're using high-rolling chips you can almost guarantee that a casino knows what you're up to. Loss-resistant golf balls, let's golf players to no longer worry about straining to scan for the ball and getting sick of losing golf balls in the long stuff. RFID also offers a Hygiene Solution to Healthcare to tackle the simple, but serious problem of getting health care workers to wash their hands. Workers wear a wristband and RFID readers are positioned by the faucets. Another interesting application of RFID has been in Car Rental services, enabling customers to access and then return the rental cars without having to submit the usual paperwork and spend time at a manned desk. It recognizes vehicle returns and allows customers to park in any open spot and go.

The aim of this paper is to demonstrate the working model of Smart Cart System. The rest of this paper is organized as follows. First, related works in RFID technology with its merits and demerits are reviewed in Section 2.The taxonomy of RFID technologies is studied in this section as well. In Section 3, System Architecture is developed with the Algorithm. Section 4 explains about the modules in the proposed system and about the Software and Database used. In Section 5, the performance of this system is evaluated with the existing one. Finally, Conclusions are drawn and future work is pointed out in Section 6.

II. RELATED WORKS

The RFID technology has been made use in several applications. Some of those technologies are explained as follows.

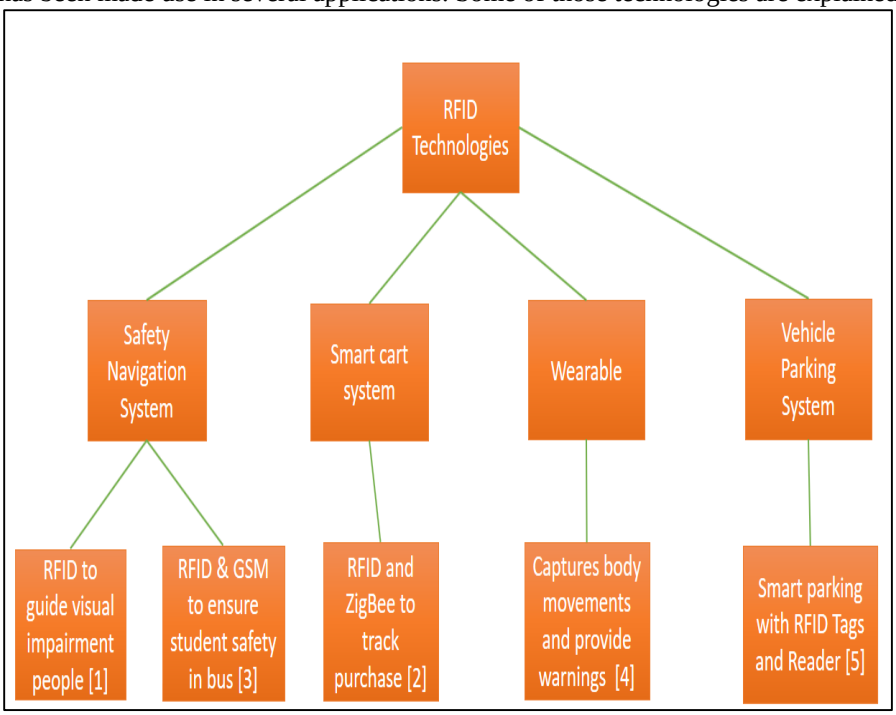

Fig. 1: Taxonomy of RFID Technologies

A. Safety Navigation System

This system generically specifies the intelligent methodologies that could be used to ensure safety while a person moves in an unfamiliar environment or while travelling in a vehicle. Several technologies are incorporated into a system or a prototype that could be developed.

Fernandeset. al. [2] 2014, proposes a prototype which uses RFID technology to provide location-based services and navigation to the blind, or visually impaired, both indoor and outdoor, complementing the traditional white cane and providing information about the user's geographical context. These systems use the Global Positioning System (GPS) to track in outdoor environment since GPS signals cannot easily penetrate and/or are greatly degraded inside of buildings. Several technologies have been proposed to make navigation inside of buildings possible. One such technology is Radio-Frequency Identification (RFID). The advantages of this system is using a mesh infrastructure optimal routes can be calculated, reducing the overall distance that the user must travel to reach the desired destination. One of the limitations of this system is the use of cluster topology, which keeps the user on safe paths, but lacked some of the versatility that normally sighted users had while navigating.

R. Malliga et. al. [4] 2016, developed an"RFID-based System for School Children Transportation Safety Enhancement". The proposed system will control the entry and exit of students to and from the bus using RFID (Radio Frequency Identification) and GSM technologies to ensure the entering and exiting of all students to and from the school bus in a safer manner. The process does not require any additional action by the student and drivers. The system will do all the process and allow the student to be

tracked while entering and leaving the bus and if all the students were wearing seat belts mean, it will allow bus driver to start the bus for safety precaution. If the bus journey is successful from the source to destination, it will send an SMS to the management to inform its departure and arrival. The limitations of this system are: In case of any unfortunate incidents such as an accident, the parents will be not be notified about the safety of their children. The merits of this system are: Parents learn about the whereabouts of their children automatically from any location without having to make a call to the driver or the school.

B. Smart Cart System

This system helps the customer to keep track purchased products by enabling them to see the total/subtotal amount when they place them in the cart. It also involves display of items to the customer based on their previous purchase details, in addition displaying any offers, etc. It also provides a provision for the online transaction for bill payment.

Ankush Yewatkaret. al. [3] 2016, proposed the Smart Cart with Anti-Theft that will keep the track of purchased products and also online transaction for billing using RFID and ZigBee. The system will also give suggestions for products to buy based on user purchase history from a centralized system. In this system, every product in Mart will have RFID tag, and every cart will be having RFID Reader and ZigBee attached to it. There will be a centralized system for the recommendation and online transaction. Moreover, also there will be RFID reader at the exit door for anti-theft. The advantages of this system are: Relieves the customer from selecting the right product and also saves the user time from standing in line for billing all the goods. The limitations of this system are: The ZigBee is vulnerable to various network attacks like Sniffing, Data modification etc. and network penetration.

C. Wearables

Now-a-days most of the technologies involve the wearable as their major credit to achieve uniqueness and user friendliness. Some of the wearables are smart watches, wrist bands, smart glasses, etc.

Liang Wang et. al. [6] 2017, introduced RFID tag wearables that are worn on the body parts of the elderly people along with an RFID reader worn on the waist. The different body movements of the person are captured and read by the reader in order to monitor his/her activities and provide the necessary care and warnings. The limitations of this system are : a person in close proximity to another, may have the latter's body movements being read and hence can lead to a wrong result , inconvenience caused by wearing the RFID wearables all over the body , damage of RFID equipment's due to carelessness . The merits of this system are: it provides easy and remote care for the elderly.

D. Vehicle Parking System

This system provides some smart techniques for parking which helps in reduction of the time spent in paying amount for parking and to wait in a long queue to park your vehicles. The system to be developed will make your payment online and ensures easy identification of free parking space at a particular time.

Karma TshetenDorjeeet. al. [5] 2016, proposed a project for vehicle parking management. The vehicle owner has to first register the vehicle with the parking owner and get the RFID tag. When the car has to be parked, the RFID tag is placed near the RFID reader, which is installed near the entry gate of the parking lot. As soon as the RFID tag is read by the reader, the system automatically deducts the specified amount from the RFID tag and the entry gate boomer opens to allow the car inside the parking area. The possible limitations: may not be feasible for large parking spaces such as in stadiums and exhibitions due to the increased number of tags needed simultaneously for a given duration of time. The merits of this system are: it reduces the amount of time spent in long queues at the entry gate.

III. SYSTEM MODEL

A. System Architecture

Architecture diagram is used to understand how the Smart Cart System is functioning. It describes the components and its interactions, with internal behaviour of the system. The Arduino UNO is used for processing and logical functions. UART is used for serial communication. The wireless transmitter-receiver enables wireless transfer and reception of information in the PC.

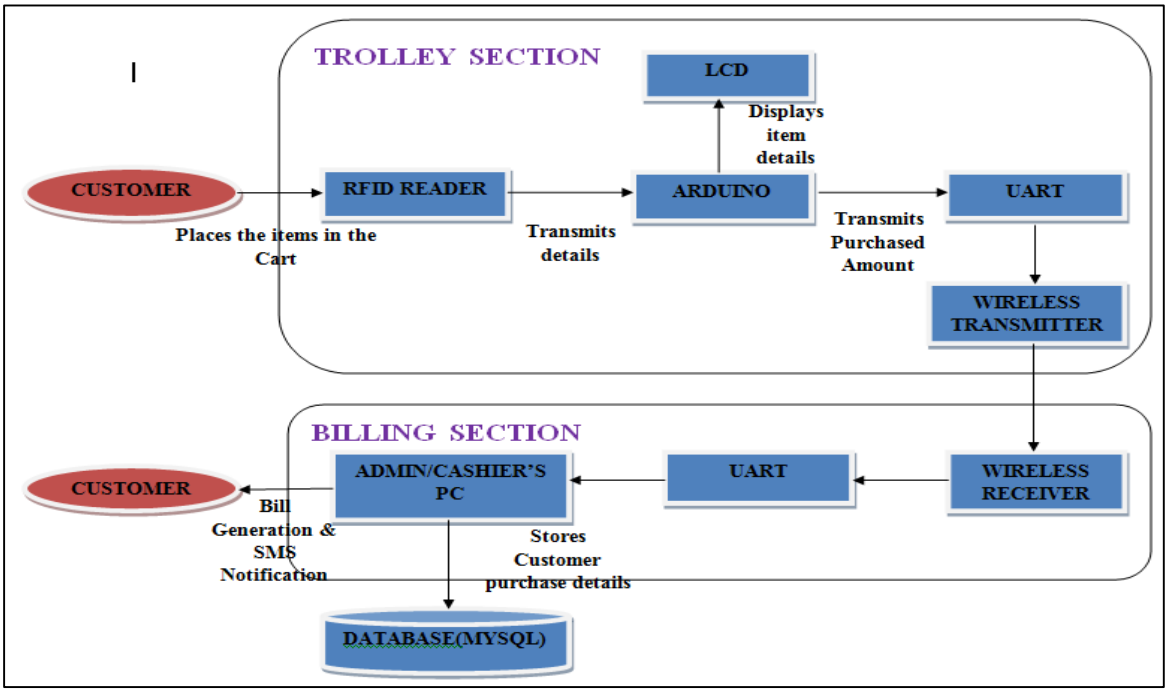

Fig. 2: Automated Shopping Cart - System Architecture

B. Algorithm

1) RFID Detection

1) START
2) Add the <LiquidCrystal.h> header file
3) Initialize the library with the numbers of the interface pins
4) Make the following variable declarations and initializations
a) Variable to denote the completion of RFID tag number input, from user (boolean)
b) Variable to hold the incoming RFID tag number (String)
c) 'switch' and 'flag' variables , initialized to 0 (integer)
d) Variable to store the amount , initialized to 0 (integer)
5) setup() method of type void
{
a) Begin the serial communication at 9600 bits per second
b) Set up the LCD's number of columns and rows
c) Set the pin numbers for input and output
d) Set the cursor position to beginning of the LCD (0,0)
}
6) loop() method of type void
{
a) Read the input of the removal switch
b) If it is low, set the flag value to 1
c) After the RFID tag input string is completely read , and if the flag value is 0
– Find an appropriate match for the tag number read
– Set cursor position
– Display details
– Increment amount
d) Else : After the RFID tag input string is completely read , and if the flag value is 1
– Find an appropriate match for the tag number read
– Set cursor position
– Display details
– Decrement amount
e) Set the cursor position and display the amount
}
7) setEvent() method of type void: executed whenever new data comes into the hardware serial RX.

{
a) Set up a loop that gets the RFID tag number as input from the user
b) Concatenate the character read on each iteration of the loop, to the input string
c) If a newline is encountered, stop and set the variable that denotes the completion of RFID tag number input, to 'true'
}
8) STOP

2) Desktop Application
1) START
2) Form1 {
Create a login form (form 1) for cashier/ admin. Perform necessary database connectivity.
}
3) Form2
{
Create another form (form 2) that has fields to take in the transferred items details, from the cart.
Add a START button to start transfer of cart item details to the PC.
Add a PRINT button to navigate to the bill page and print the bill.
}
4) Form3
{
Create a third form that displays the bill that is printed.
Add an UPDATE button that updates the bill/transaction in the database. Perform necessary database connectivity.
}
5) STOP

IV. SYSTEM IMPLEMENTATION

A. Modules

1) Item Detection / Identification
As items are placed into the shopping trolley, they should be added correctly by the RFID reader fixed in the trolley. The items detected are maintained as a list for calculating the total of their prices. When an item is removed from the trolley by pressing the removal switch, it should be deleted from the list of items maintained so far i.e. the list of items present in the trolley.

2) Price Total
As and when a new item is added to the cart, its price should be added up and displayed on the LCD provided on the trolley. This will keep the customer aware of his/her bill amount so far.Similarly, when an item is removed from the trolley, its price should be deducted from the total calculated.

3) Bill Generation
Once a customer has completed his/her purchases, he/she moves to the billing counter where the details of the list of items in the cart are transferred to the cashier's PC for bill generation. The customer then pays the final amount.

4) Customer Notification
Once all the billing procedures are complete, and the payment is made, a notification of this transaction is sent to the customer's mobile through GSM. This notification includes the name of the store and its branch, date and time of transaction and the bill for the items bought.

B. Software and Database Used
Visual Basic is a third-generation event-driven programming language and integrated development environment (IDE) from Microsoft for its Component Object Model (COM) programming model. Visual Basic was derived from BASIC, a user-friendly programming language designed for beginners, and it enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using

Data Access Objects, Remote Data Objects, or ActiveX Data Objects, and creation of ActiveX controls and objects. Programming in VB is a combination of visually arranging components or controls on a form, specifying attributes and actions for those components, and writing additional lines of code for more functionality. Since VB defines default attributes and actions for the components, a programmer can develop a simple program without writing much code.

MySQL is an open source relational database management system (RDBMS) based on Structured Query Language (SQL). MySQL runs on virtually all platforms, including Linux, UNIX and Windows. Although it can be used in a wide range of applications, MySQL is most often associated with web-based applications. MySQL is written in C and C++. Its SQL parser is

written in yacc, but it uses a home-brewed lexical analyser. MySQL works on many system platforms. Major features as available in MySQL are: Cross-platform support, stored procedures, Triggers, Cursors, Updatable views, Online DDL, Query caching and so on.

C. System Working Model

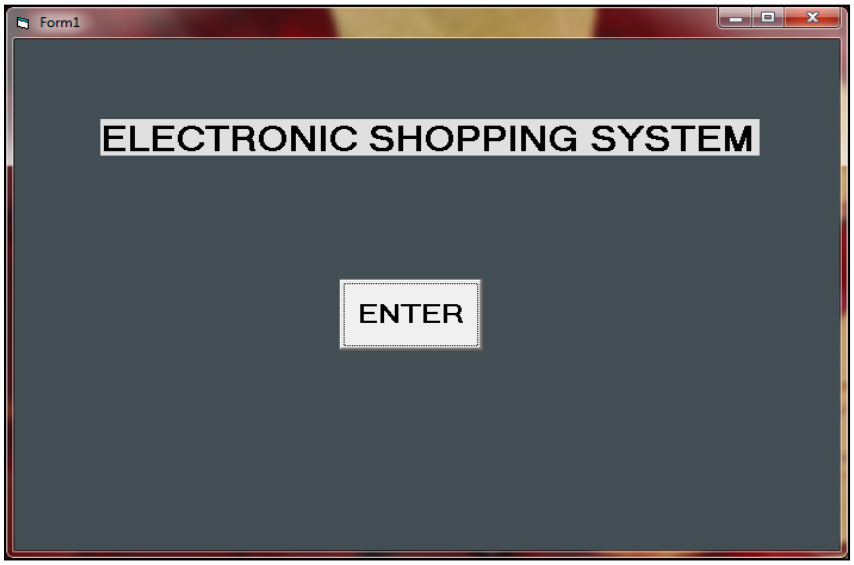

Fig. 3: Desktop Application –Home page

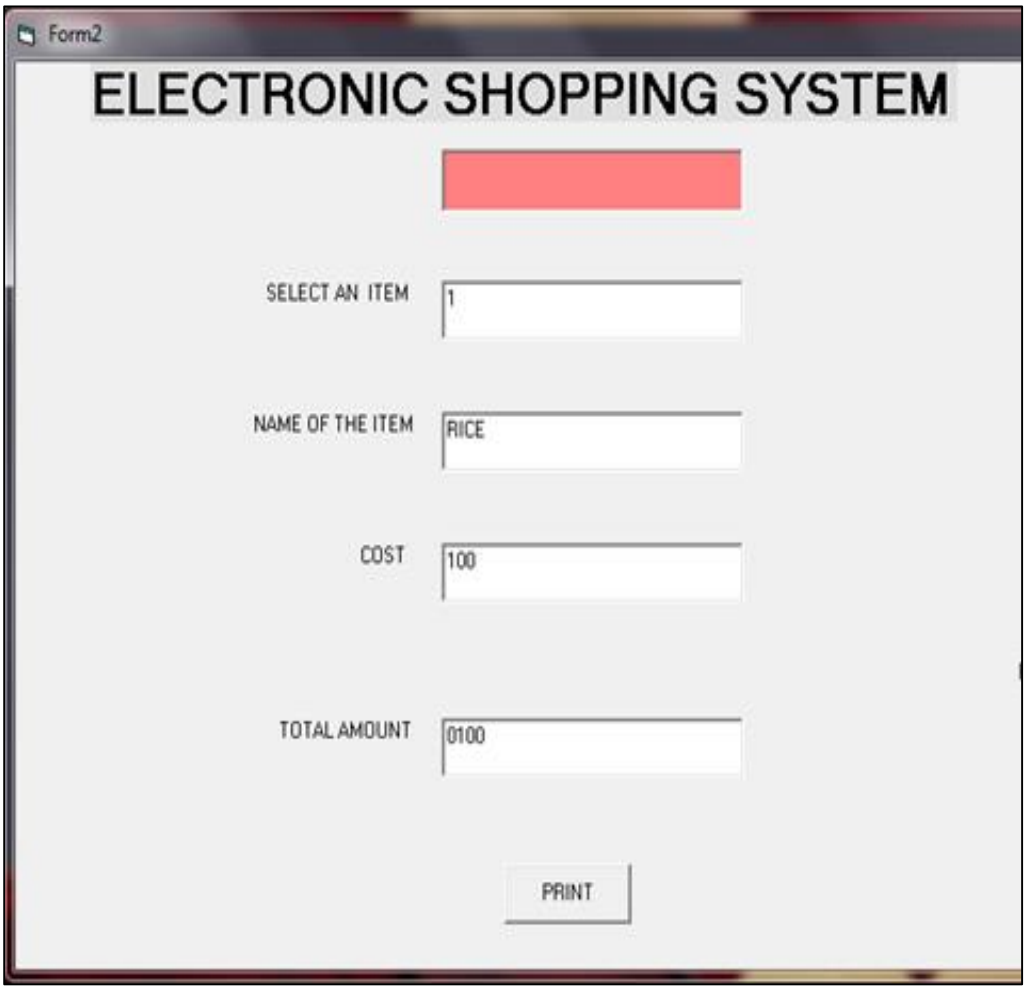

Fig .4: Desktop Application –Purchase Details page

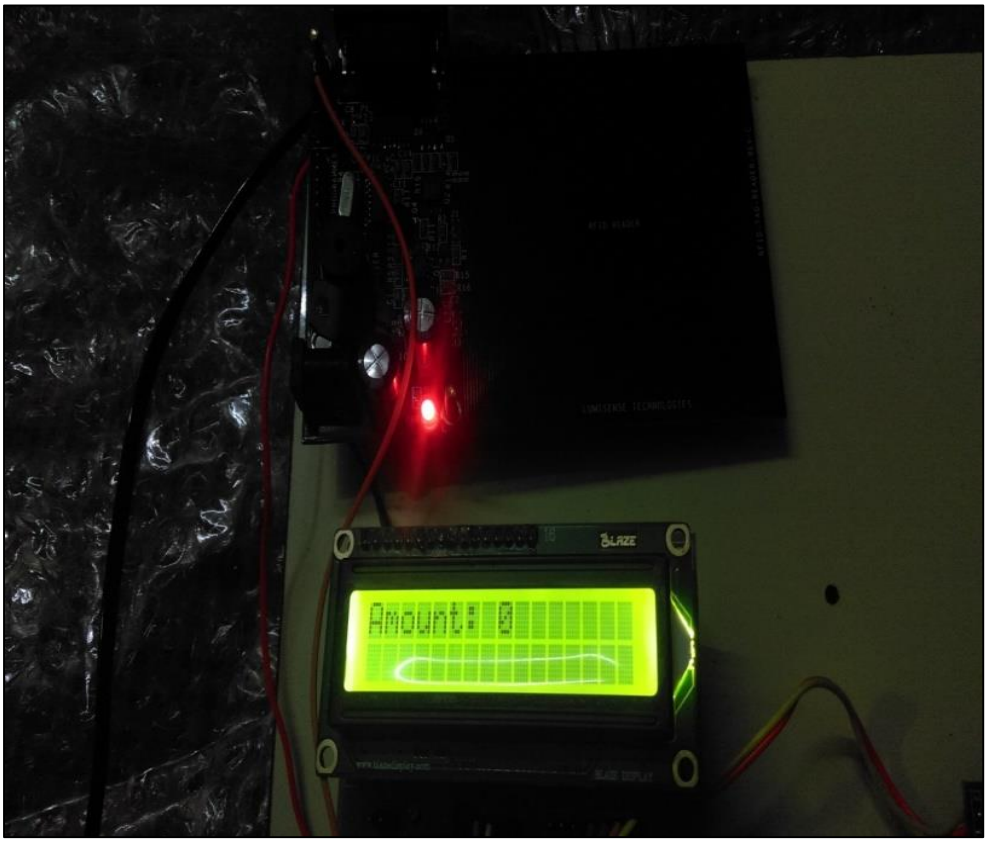

Fig. 5: Cart hardware – Before Placement of Items

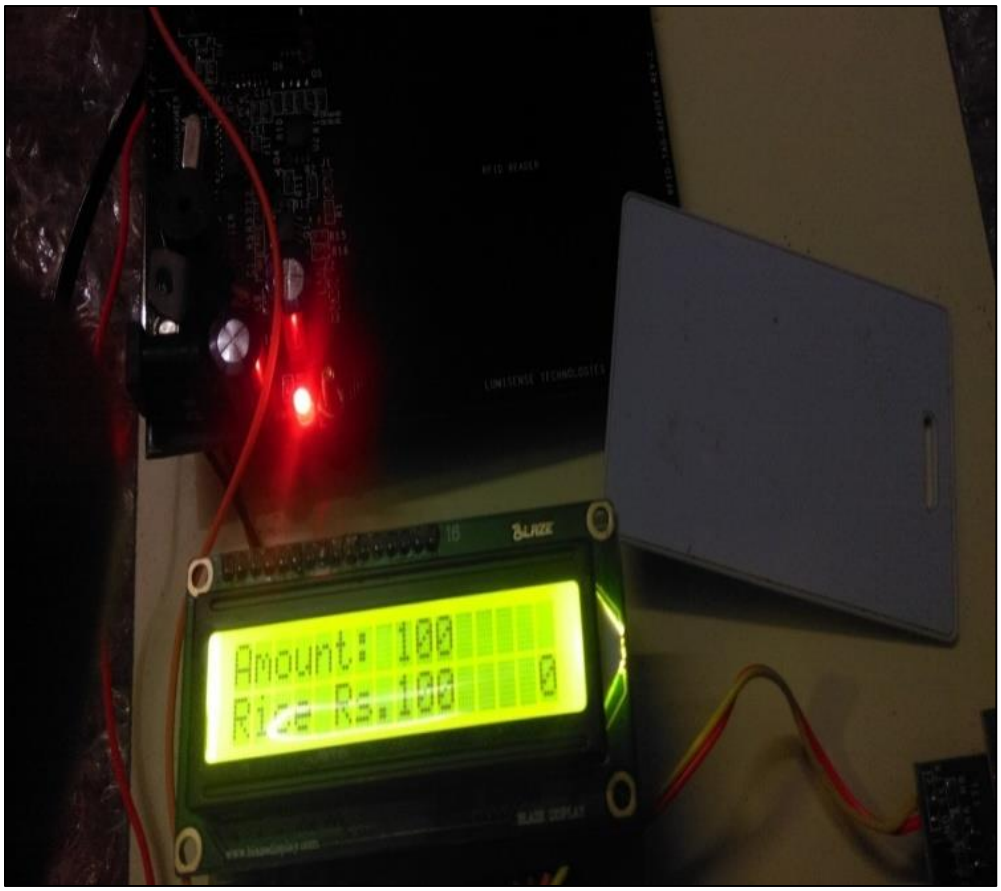

Fig .6: Cart hardware – After Placement of 1 Item

The above figures depict a sample case of the proposed system's implementation. Fig.3displays the home page of the shopping application after login. Fig.4 shows the price and name of a sample item in the cart. Fig.5 displays the initial amount on the cart LCD screen, when no items have been placed yet. In Fig.6, the item name and its price along with the subtotal of prices of items placed so far in the cart are displayed on the cart's LCD screen.

V. Discussion

The traditional shopping system at physical stores involves manual scanning of the products bought and long queues at the billing counter. This is time consuming and tedious. While shopping consumers face many problems like worrying that amount of money brought is not sufficient, incomplete information about the items and so on. An automated approach can be adopted to save time and efforts. Such a solution can be used to reduce problems of having enough spatial requirements to house a large crowd of people at the billing point. Through the RFID implementation of automatic recognition, technologies become easier for smart cart. With the help of wireless networks, RFID makes the conventional retail process fast, transparent and efficient.

No. of products per customer	Processing Time(Minutes) for Existing system	Processing Time(Minutes) for Proposed system
1	3.25	2.243
2	6.68	2.243
3	10.001	2.243
4	13.393	2.243
5	16.25	2.243
6	19.561	2.243

Table 1: Data for the comparison between the smart cart and traditional cart system

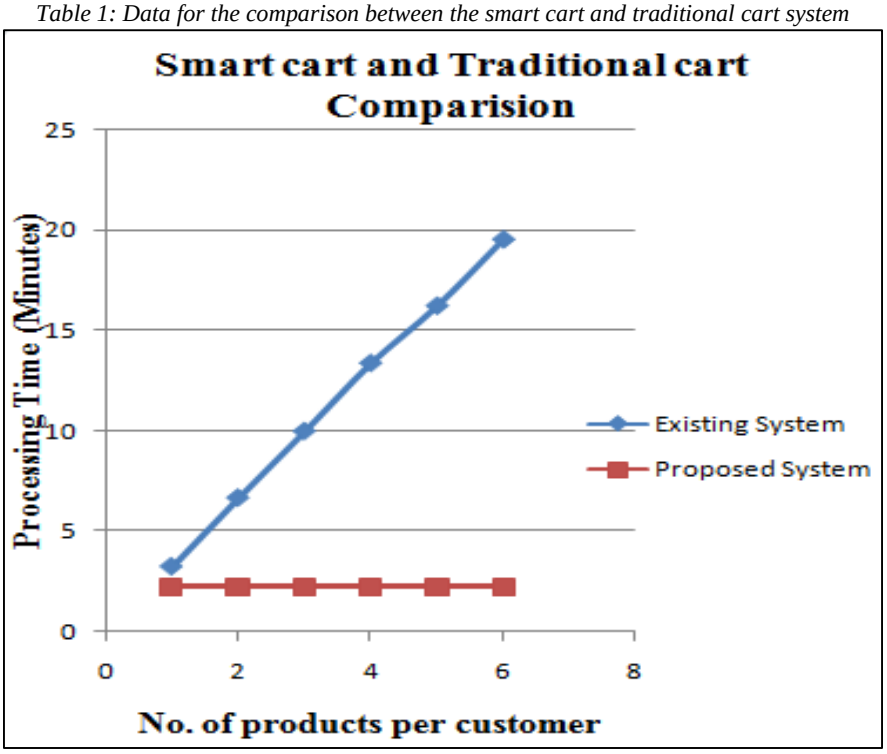

Fig. 7: Comparison between the existing and proposed shopping system with respect to processing time for varying number of products

VI. Conclusion And Future Work

Thus, in the proposed system, each product will have an RFID tag embedded into it and each cart will have an RFID reader that will detect each product on its placement into the cart. The controller in this cart will calculate the sub-total/total on adding or

removing items. The bill will be automatically transferred to the cashier's PC via wireless LAN and notification will be sent to the customer's mobile via GSM. This system will help the customer in saving his/her time and effort. It also avoids the need for maintaining a large space in the shop to manage a large crowd. However, one of the issues in the project is that if the product is not placed inside the cart, there might be a chance for not adding that amount which may end up in theft. Hence, in the forthcoming model we can provide a provision by which the total amount of purchase could be automatically deducted from the Customers' banking account. A notification about the purchase along with the amount deduction from his/her account can be sent to the customers' mobile via GSM. In addition, we could work on how to provide the anti-theft functionality.

REFERENCES

[1] Igor Bisio, Andrea Sciarrone , SandroZappatore , "A new asset tracking architecture integrating RFID, Bluetooth Low Energy tags and ad hoc smartphone applications," Pervasive and Mobile Computing,vol.31,pp.79-93,2016.
[2] Fernandes.H.a, VitorFilipea.b , Paulo Costac, Joao Barroso, "Location based services for the blind supported by RFID technology," 5th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion, DSAI 2013,vol.27,pp.2-8,2014.
[3] AnkushYewatkara, FaizInamdarb, Raj Singhc, Ayushyad, AmolBandale,"Smart Cart with Automatic Billing, Product Information, Product Recommendation Using RFID&Zigbee with Anti-Theft," 7th International Conference on Communication, Computing and Virtualization 2016,vol.79, pp.793-800, 2016.
[4] R.Malliga.ME,T.Narmatha,"RFID-based System for School ChildrenTransportation Safety Enhancement," International Journal of Advanced Research in Computer Science and Software Engineering,vol.no.6,issue 4, pp.471-475, 2016.
[5] Karma TshetenDorjee, Deepak Rasaily ,BishalCintury, "RFID-Based Automatic Vehicle Parking System Using Microcontroller," International Journal of Engineering Trends and Technology (IJETT),vol.32,No.4,pp.191-194,2016.
[6] Liang Wang, Member,TaoGu, Senior Member,Xianping Tao, Member, and JianLu,Member,"Toward a Wearable RFID System for Real-Time Activity Recognition Using Radio Patterns," IEEE TRANSACTIONS ON MOBILE COMPUTING,vol.16,No.1,pp.228-242, 2017.
[7] https://learn.adafruit.com/adafruit-arduino-lesson-11-lcd-displays-1/arduino-code
[8] http://www.circuitbasics.com/how-to-set-up-an-lcd-display-on-an-arduino/
[9] http://arduinobasics.blogspot.in/2012/07/arduino-basics-simple-arduino-serial.html
[10] https://www.arduino.cc/en/Reference/Setup