

Wireless Integrated Passive Rfid Based Shopping System

¹Sivagnanam.G, ²Chandragupta Mauryan. K.S, ³Karthikaa.T, ⁴Mirudhula.G, ⁵Prem Kumar.V and ⁶Karthick.S,
^{1,2,3,4,5,6}Electrical And Electronics Engineering, Sri Krishna College of Technology, Coimbatore, Tamilnadu, India

Abstract—The Automated Shopping Trolley is a Smart Trolley which integrates a Embedded Chip with RFID reader with tag and a Battery kit to allow users to self-checkout at Super Markets. Everyone knows the importance of time in this competition world and no one wants to waste their time in doing regular things. If we consider any shopping mall we have to wait much time for billing even though you purchase little things and we are not aware of cost of the product that we wanted to purchase. With the help of this project we reduce the billing time and customers can know the exact cost of the products that they purchased before billing so that they can do their shopping within their budget. RFID is the key technology that we are using in this project.

Keywords—RFID (Radio Frequency Identification), Zigbee, Universal Product Code (UPC)

I. INTRODUCTION

RFID stands for Radio-Frequency Identification. The acronym refers to small electronic devices that consist of a small chip and an antenna. The chip typically is capable of carrying 2,000 bytes of data or less. RFID reader circuit generates 125kHz magnetic signal. The card number is read by the magnetic signal transmitted by the loop antenna. The RFID device serves the same purpose as a bar code or a magnetic strip on the back of a credit card or ATM card; it provides a unique identifier for that object. And, just as a bar code or magnetic strip must be scanned to get the information, the RFID device must be scanned to retrieve the identifying information.

In this project RFID card is used as security access card. Each product has an individual RFID card representing the product name which is interfaced with a microcontroller. Microcontroller used here is a flash type reprogrammable type with a card number which is already programmed. This is interfaced with keypad.

II. LITERATURE REVIEW

A. Introduction to RFID

RFID is Radio Frequency Identification which uses electromagnetic fields to identify and track the tag objects. In 1945, Léon Theremin invented an espionage tool for Soviet Union, which with the help of incident radio waves retransmitted the audio information along with the radio waves. These sound waves vibrated a diaphragm which alters the shape of the resonator modulating the reflected radio frequency. This device is only a covert listening device, which is passive, energized and activated by waves from an outside source. Similarly, IFF transponder was used in World War-II by allies and Germany to identify the air craft as friend or foe. Mario Cardullo's device was the ancestor of modern RFID, as it was passive radio transponder with memory.

B. RFID System Components and Their Effects in Libraries

An RFID system consists of three components: the tag, the reader and the application that makes use of the data the reader reads on the tag. Tag is a two way radio transmitter-receiver called interrogators that sends signal to the tag and reads its response. It consists of an antenna and a silicon chip encapsulated in glass or plastic. The tags contain a very small amount of information. For example, many tags contain only a bar code number and security bit (128 bits) but some tags contain as much as 1,024 bits (Boss, 2003). Tags range in size from the size of a grain of rice to two inch squares depending on their application. Researchers are now working on tags as small as a speck of dust. Tags can be passive, active or semi-active. An active tag contains some type of power source on the tag, whereas the passive tags rely on the radio signal sent by the reader for Power. Most RFID applications today utilize passive tags because they are so much cheaper to manufacture. However, the lack of power poses significant restrictions on the tag's ability to perform computations and communicate with the reader. It must be within range of the reader to function. Semi-active tags are not yet commercially available but will use a battery to run the microchip's circuitry but not to communicate with the reader. Semi-active tags rely on Capacitive coupling and carbon ink for the antennas rather than the traditional inductive coupling and silver or aluminium antenna used in passive tags (Collins, 2004). Tags operate over a range of frequencies. Passive tags can be low frequency (LF) or high frequency (HF). LF tags operate at 125 KHz, are relatively expensive, and have a low read range (less than 0.5 meters). HF tags operate at 13.56 MHz, have a longer read range (approximately 1 meter) and are less expensive than LF tags. Most library applications use HF tags (Allied Business Intelligence [ABI], 2002). Tags can be Read Only (RO), Write Once Read Many (WORM) or Read Write (RW) (Boss, 2003). RO tags are pre-programmed with a unique number like a serial number (or perhaps eventually an ISBN number). WORM tags are pre-programmed but additional information can be added if space permits. RW tags can be updated dynamically. Sometimes space on the RW tags is locked where permanent data is kept and the rest of the tag is writable.

C. RFID System Components and Their other field

Once the reader reads the tag, the information is passed on to an "application" that makes use of the information. Examples of applications and their uses fall into at least six categories:

1. Access control (keyless entry)
2. Asset tracking (self check-in and self check-out)
3. Asset tagging and identification (inventory and shelving)
4. Authentication (counterfeit prevention)
5. Point-of-sale (POS) (Fast Track)
6. Supply chain management (SCM)

(Tracking of containers, pallets or individual items from manufacturer to retailer) RFID is most pervasive in the SCM market. ABI (2002) reports that by 2007, SCM and asset management applications will account for more than 70% of all transponder (tag) shipments. In the SCM market, items are tracked by pallet or container, not by individual item. Once the individual items are removed from the pallet, they are no longer tagged. In contrast, library applications require that each individual item contain a tag that uniquely identifies the item (book, CD, DVD, etc). The tag contains some amount of static data (bar code number, manufacturer ID number) that is permanently affixed to the library item. This information is conveyed, via reader, to the library's security, circulation and inventory applications.

III. EXISTING SYSTEM

RFID technology is amongst the most revolutionary technologies that will shape tomorrow's pervasive retail sales. When a customer visiting a self-service store to improve shopping experience this technology is used. Due to the emergence of low cost RFID tag manufacturing procedures barcode systems are replaced with this technology.

Nowadays, if a consumer would like to buy something at a shopping mall, consumers need to take the particular items from the display shelf and then queue up and wait for their turn to make payment. Problem will surely arise when the size of a shopping mall is relatively huge and sometimes consumers don't even know where certain items are placed. Besides, consumers also need to queue for a long time at the cashier to wait for turn to make payment. The time taken for consumers to wait for the customers in front of the queue to scan every single item and then followed by making payment will definitely take plenty of time. This condition will surely become worst during the season of big sales or if the shopping mall still uses the conventional way to key in the price of every item by hand to the cash register. On the other hand, consumers often have to worry about plenty of things when going to the shopping mall.

For example, most consumers will worry the amount of money brought is not enough to pay for all the things that wanted to be bought until it comes to our turn to pay at the cashier, consumers might also worry that whether certain food product available at the shopping mall or not, or suitable for vegetarian since most of the food product might not be stated clearly.

It will be a great convenience if the information of items that are available in the shopping mall can be obtained. It will be a great improvement on the existing system if the technology of RFID is implemented. Consumers will be able to get information of all the items at shopping mall, total up the prices of items as they shop, and save unnecessary time at the cashier.

A. Shopping Technologies

- Lack of Shopping Experience – People don't have to stand in line and wait for checkout. – Online Billing System.
- Logistics of Inventory Management
- No Intercom Module Support
- Barcode Technology – Barcode can only read one item at a time. – Failure rate in Barcodes are relatively high for self-checkout system.

IV. PROPOSED SYSTEM

This paper is convenient purchasing method for customers in shopping complex. In this project we use RFID card for accessing security of the product. Each product will have an individual card representing the product name. Once the product is put into the trolley, it will show the total amount along with the price of each product. The microcontroller used here is flash type reprogrammable in which we already programmed with card number. It is interfaced with keypad. So this improves security performance and also speed.

The figure shows the concept of Central Automated Billing System. Since each cart is attached with product identification device (PID), through ZigBee communication PID sends its information to central automated billing system, there it calculates net price for the purchased products. Customer can get their billing information at the packing section according to their Cart Identification Number. Even there's is no need for a cash collector, in case customer uses their debit/credit for bill payment. The Automated central billing system consists of a product database. The automated billing system will be developed using visual basic. Visual Basic was designed to accommodate beginner programmers. Programmers can not only create simple GUI applications, but to also develop complex applications. 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 actions and attributes for the components, a programmer can develop a simple program without writing much code. Programs built with earlier versions suffered performance problems, but faster computers and native code compilation has made this less of an issue.

A. Improving shopping Management

Using radio-frequency identification RFID data, which show the position of a shopping cart through an RFID tag attached to the shopping cart. The RFID data contain valuable information for marketing, such as shopping time and distance as well as the number of shelf visits. The authors analyse customers' purchasing behaviour and in-store movement information using POS data combined with RFID data. The purpose of this study is to discover a promising shopping path that can distinguish customers' in store movements by sequential pattern analysis using RFID data. These shopping paths are extracted using a pattern mining method. Finally, shopping paths are used in the decision tree analysis to generate the rules that expressed customers' in-store movements and purchasing characteristics

B. Improving Commodity Allocation

To be able to deploy commodities for sale in different shelves in a supermarket in order to obtain better benefit for sellers with considering convenience for buyers is an important topic in the retail area. A new method for allocating commodity shelves in supermarket based on customers' shopping paths and transactions data mining is being used by researchers. Here customers' shopping paths data can be obtained by shopping cart which has RFID tags embedded and shopping transaction data can be obtained from POS technology. Through integrating and mining the frequent paths data and transactions data, the See-Buy Rate - an approximate probability to purchase this commodity when they see the commodity, can be calculated. Based on SeeBuy Rate, we build benefit optimization model to obtain the

optimal allocating solution with considering the profit, sales volume, and purchase probability of the commodity.

port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

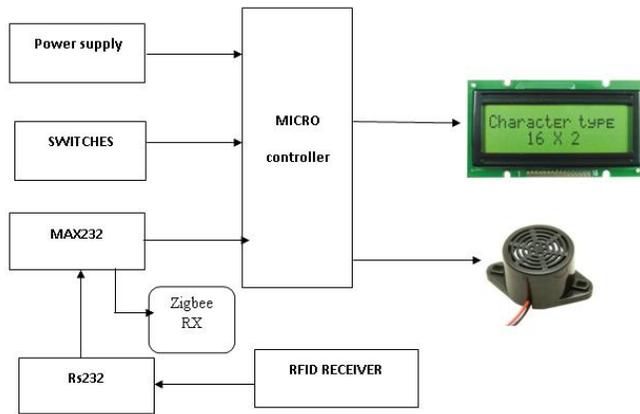


Figure 1: Trolley Section

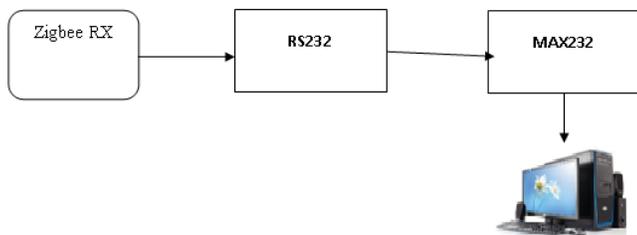


Figure 2: Server section

C. Hardware Implementation and Design of Cart

The given fig.1 shows hardware modules for the device which is attached to shopping cart of supermarket. It consists of a microcontroller, display unit (LCD), an EEPROM, RFID reader, ZigBee transceiver and a battery power source. The battery power source increases the mobility of the device. A liquid crystal display is special thin flat panels that can let light go through it, or can block the light. Each block is filled with liquid crystals that can be made clear or solid, by changing the electric current to that block. Liquid crystal displays are often abbreviated LCDs.

1. Microcontroller

The PIC16F877A is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. This device is manufactured using Atmel's high-density non-volatile memory technology. It is compatible with the industry standard instruction set and pin out. The on-chip Flash allows the program memory to be a conventional non-volatile memory programmer, by combining a versatile 8-bit CPU with in-system programmable

Flash on a monolithic chip, the PIC16F877A is a powerful Microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, Watchdog timer, two data pointers, three 16-bit timer/counters, 32 I/O lines, a six-vector two-level interrupt architecture, a full duplex serial port, clock circuitry and on-chip oscillator. In addition, the PIC16F877A is designed with static logic for operation down to zero frequency. It also supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial

2. ZigBee

ZigBee is a high level communication protocol used to create personal area networks with small, low-power digital radios such as medical device data collection, home automation etc., ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless M2M networks. The ZigBee standard operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz. ZigBee compliant wireless devices are expected to transmit 10-75 meters, depending on the RF environment and the power output consumption required for a given application, and will operate in the unlicensed RF worldwide (2.4GHz global, 915MHz Americas or 868 MHz Europe). ZigBee is expected to provide low cost and low power connectivity for equipment that needs battery life as long as several months to several years but does not require data transfer rates as high as those enabled by Bluetooth. In addition, ZigBee can be implemented in mesh networks larger than is possible with Bluetooth. The data rate is 250kbps at 2.4GHz, 40kbps at 915MHz and 20kbps at 868MHz. The below fig 2 shows the ZigBee module CC2500 transceiver.



Figure 3: zigbee

3. RFID Reader

RFID Proximity OEM Reader Module has a built-in antenna with a minimized form factor. It is designed to work on the industry standard carrier frequency of 125 kHz. An RFID reader's function is to interrogate RFID tags. The means of interrogation is wireless and because the distance is relatively short; line of sight between the reader and tags is not necessary. This LF reader module with an internal or an external antenna facilitates communication with Read-Only transponders—type UNIQUE or TK5530 via the air interface. The tag data is sent to the host systems via the wired communication interface with a protocol selected from the module Both TTL and Wiegand Protocol.

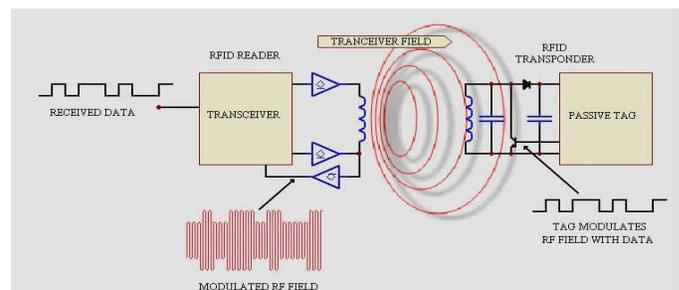
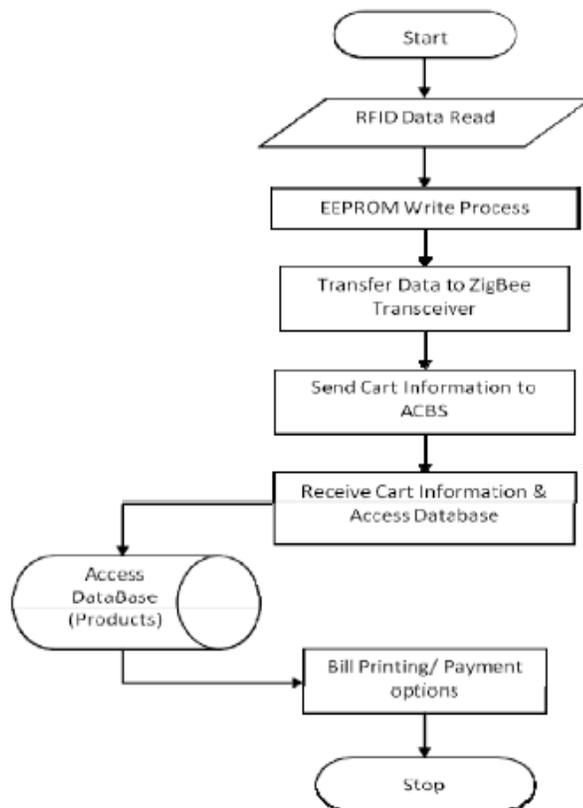


Figure 4: RFID transmission

Once the consumer gets his desired product from the shelf in the retail store and puts it into the cart, the RFID reader reads the tag on the product and the product information is displayed on the LCD screen. Side by side, the billing information is also updated. The working of the smart shopping cart can be explained in the following steps:

1. When shoppers with the cart press "start button" the system turns ON and then all the components such as RFID reader microcontroller and ZigBee start working.
2. Every product has an RFID tag which contains a unique id. They are fed in the database assigned to the corresponding products.
3. When the shopper puts any product in the cart then the tag is read by the RFID reader. The information of the product is extracted and displayed on the LCD screen. Also side by side, the billing information is also updated.
4. These steps are repeated until the end of shopping button is pressed. Once the "End Shopping" button is pressed the total bill is sent to master pc via Wi-Fi (ZigBee).
5. There is also an option provided to delete some of the products from the cart and the bill will be updated accordingly, this goes by the customer choice.
6. At the end of shopping, the customer can straight away pay the bill and leave.
7. Inventory status of the products is also updated at the end of shopping.

4. Flow Chart



CONCLUSION AND DISCUSSION

This application creates an automated central bill system for supermarkets and mall. Using PID, customers no need to wait near cash counters for their bill payment. Since their purchased product information is transferred to central billing system. Customers can pay their bill through credit/debit cards. The 8-bit microcontroller used here has the capability of receiving 8-bit data from RFID reader. The pic16f877a doesn't have inbuilt UART protocol,

Programmer has to create a separate EMBEDDED C program to communicate with EEPROM. This may create some difficulties in writing program for programmers to synchronize. Some of other microcontrollers and microprocessors have inbuilt UART protocol features. Those can be used as further improvement in efficiency and compatibility of this application.

References

- [1] Y. J. Zuo "Survivable RFID systems: Issues, challenges, and techniques", IEEE Trans. Syst., Man, Cybern. C, Appl. Rev., vol. 40, no. 4, pp.406 -418 2010
- [2] F. Gandino , B. Montrucchio , M. Rebaudengo and E. R. Sanchez "On improving automation by integrating RFID in the traceability management of the agri-food sector", IEEE Trans. Ind. Electron., vol.56, no. 7, pp.2357 -2365 2009
- [3] T. M. Choi "Coordination and risk analysis of VMI supply chains with RFID technology", IEEE Trans Ind. Informat., vol. 7, no. 3, pp.497 -504 2011
- [4] J. D. Porter and D. S. Kim "An RFID-enabled road pricing system for transportation", IEEE Syst. J., vol. 2, no. 2, pp.248 -257 2008
- [5] H. H. Bi and D. K. Lin "RFID-enabled discovery of supply networks", IEEE Trans. Eng. Manag., vol. 56, no. 1, pp.129 -141 2009
- [6] K. Finkenzerler RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identification, 2003 :Wiley
- [7] J. Z. Gao , L. Prakash and R. Jagatesan "Understanding 2D-BarCode technology and application in M-commerce-design and implementation of a 2D barcode processing solution", Proc. Comput. Softw. Appl. Conf., pp.49 -56 2007
- [8] D. Hahnel , W. Burgard , D. Fox , K. Fishkin and M. Philipose "Mapping and localization with RFID technology", Proc. IEEE Int. Conf Robot. Autom., pp.1015 -1020 2004
- [9] J. Y. Zhou , J. Shi and X. L. Qiu "Landmark placement for wireless localization in rectangular-shaped industrial facilities", IEEE Trans. Veh. Technol., vol. 59, no. 6, pp.3081 -3090 2010
- [10] S. S. Saad and Z. S. Nakad "A standalone RFID indoor positioning system using passive tags", IEEE Trans. Ind. Electron., vol. 58, no. 5, pp.1961 -1970 2011