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Intelligence Billing System Using Radio Frequency Identification (RFID) and ZIGBEE

Lokesh.A[1], Basamma Patil[2], Divya.P[3]
Lokesh.A, Assistant Professor CSE,M.S.Engineering College,Bengaluru.
Basamma Patil, Assistant Professor CSE,SJB Institute of Technology.
Divya.P, Assistant Professor CSE,M.S.Engineering College,Bengaluru.

Abstract: *As we know that there is a huge crowd in the malls in metro cities. Especially it becomes more crowded on holidays. People purchase different items in the malls and puts them in the trolley. At the cash counter billing process is done using bar code scanner. This is very time consuming process. To avoid this we are developing a system which we called as* ***"Intelligence Billing System Using RFID and ZIGBEE"****. In this system we are using RFID tags instead of barcodes. This RFID tags will be on the product. Whenever the customer puts a product into trolley it will get scanned by RFID reader and product price and cost will be displayed on LCD display. Like this the process goes on. We are using ZIGBEE transmitter which will be at trolley which is used to transfer data to main computer. At the main computer ZIGBEE receiver will be placed which will receive data from transmitter. To store the products price and total billing memory used will be Atmel AT24C04. LCD used will be 16X2 alphanumeric displays. It will be used to display products names, products cost etc.*

Keywords: *RFID , ZIGBEE,BARCODE*

I. Introduction

A shopping mall or shopping centers a set of buildings with retail shops with interconnecting walkways enabling visitors to easily walk from floor to floor. There has been a speeding growth in the number of shopping malls in India from late 2000 to early 2005.Within 5 years total number of malls in Mumbai has share of 31% and then Delhi, which has a share of 21% with 360 malls anticipated in India by 2007 and 600 malls by the end of 2010. The growth was fuelled by rising incomes, greater availability of credit and business lifestyles. Purchasing and Shopping at big malls is becoming daily activity in metro cities.

Waiting in lines is part of everyday life. Some estimates state that Americans spend 37 billion hours per year waiting in lines. Whether it is waiting in line at a grocery store to buy deli items (by taking a number) or

Checking out at the cash registers (finding the quickest line), waiting in line at the bank for a teller, or waiting at an amusement park to go on the newest ride, we spend a lot of time waiting. We wait in lines at the movies, campus dining rooms, the registrar's office for class registration, at the Division of Motor Vehicles, and even at the end of the school term to sell books back. Think about the lines you have waited in just during the past week. How long you wait in line depends on a number of factors. Your wait is a result of the number of people served before you, the number of servers working, and the amount of time it takes to serve each individual customer. The basic idea of this paper is based upon the lines of the "Futuristic Trolley for Futuristic Billing with amalgamation of RFID and ZIGBEE" used in the Malls and Shopping Centers. Barcodes have been in existence for many years and have been used by departmental stores and supermarkets to manage purchases of merchandize by customers and keep track of inventory. However, the barcode system is no longer the best way to business operation. Customers are tired of waiting in long, slowly moving checkout line in departmental stores, especially, in holidays. With the decrease of prices through efficiencies of technology and large-scale production of semiconductor wireless components, there has been a search for new markets in which semiconductor chips can be used. This has led to the use of RFID also known as smart tags. RFID stands for Radio Frequency Identification.

II. Literature Survey

Shopping in the present day usually involves waiting in line to get your items scanned for checkout. This can result in a great deal of wasted time for customers. Furthermore, the technology currently used in checkouts barcodes - is from another era, developed in the 1970s. Today barcodes are found on almost every item. Barcodes are a universal technology in that they are the norm for retail products; stores that own a barcode reader can process barcodes and imprint it on the products. The most important factor that is involved in barcode

scanning is that the product should be in the Line of Sight (LOS) of the reader in order to get the barcode imprinted on the product scanned.

In 2009, the University of Arkansas Information Technology Research Institute completed a study to determine the business value of RFID item-level tagging for day-to-day operations at a major luxury retailer. The chain's management evaluated the use of RFID tags in the denim category. The results demonstrated that overall inventory accuracy improved by more than 27 percent, under stocks decreased by 21 percent, and overstocks decreased by 6 percent. The study also compared how long it took to count items using RFID vs. a barcode reader. With RFID, scanning 10,000 items took two hours; scanning with a barcode reader took 53 hours. This translated into an average of 4,767 counted items per hour using RFID, and 209 items per hour using a barcode system—a 96 percent reduction in cycle-counting time.

Public awareness of RFID was heightened in recent years when the U.S. Department of Defense (DoD) and retail giant Wal-Mart required their suppliers to use RFID technology. In January of 2005 Wal-Mart's CIO stated that using RFID has resulted in a 26 percent reduction in out of stocks in the stores with RFID capabilities, and out of stock items that are replenished three times faster than those items not RFID tagged.

In April 2013, it is said; to survive in 2013 and beyond, retailers need to make it easy for consumers to buy anywhere, receive anywhere, and return anywhere. The key to this cross-channel order promising is the ability, in real-time, to locate and allocate available inventory from any location, whether in the store, in DCs, in transit, or on order from the manufacturer.

III. Problem Statement

As we know that there is a huge crowd in the malls in metro cities. Especially it becomes more crowded on holidays. People purchase different items in the malls and puts them in the trolley. At the cash counter billing process is done using bar code scanner. This is very time consuming process. To avoid this we are developing a system which we called as **"Intelligence billing system using RFID and Zigbee".**

3.1 Objective

In this system we are using RFID tags instead of barcodes. This RFID tags will be on the product. Whenever the customer puts a product into trolley it will get scanned by RFID reader and product price and cost will be display on LCD display. Like this the process goes on. We are using ZIGBEE transmitter which will be at trolley which is used to transfer data to main computer. At the main computer ZIGBEE receiver will be placed which will receive data from transmitter.

In this paper we are mainly focusing on the following points-

1. To create a billing machine which can be implemented in a trolley in shopping malls
2. The billing machine should be user friendly.
3. To extensively make use of the RFID and ZIGBEE technology.
4. To effectively read the RFID tags and display the information on the LCD display.
5. To develop this paper as cost effective as possible.
6. To minimize the time duration spent by the person at the billing counter.

IV. System Analysis

4.1 Existing System

Currently available method in shopping malls is barcode method. In this method there are barcode labels on each product which can be read through specially designed barcode readers. A barcode reader (or barcode scanner) is an electronic device for reading printed barcodes. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port. The existing trolleys are designed for easy handling and storage but they do not use any means/technology/sensors to detect the products dropped into it and also no information about the price, total cost, etc of the products are provided. The cashier scans the product through the barcode scanner and gives us the bill. But this becomes a slow process when lot of products is to be scanned, thus making the billing process slow. This eventually results in long queues.

4.1.1 Disadvantages Of Existing System

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. Some of the other disadvantages that the existing system has can be given as,

- Barcode scanners need a direct line of sight to the barcode to be able to read.
- Barcodes have no read/write capabilities; they do not contain any added information such as expiry date etc. They only contain the manufacturer and product.
- They are very labor intensive; as they must be scanned individually.
- Barcodes have less security than RFID; as they can be more easily reproduced or forged.
- Barcodes are more easily damaged; as the line of sight is needed to scan, the printed bar code has to be exposed on the outside of the product.
- If a barcode is ripped or damaged there is no way to scan the product.

4.2. Proposed System

In our Intelligence Billing system environment, each product will have the passive Radio Frequency ID tag which is bearing a unique Electronic Product Code. This Electronic Product Code provides the info like name, price etc about the product.

When the customer will put the product in the Billing Trolley, the Radio Frequency ID scans the tag and the Electronic Product Code number is known by Radio Frequency ID reader. Radio Frequency ID reader passes the Electronic Product Code to the ARM 7 micro-controller where ARM 7 compares the Electronic Product Code with the database of the system containing various products. After that the name and price of the product obtained by the ARM gets displayed on the LCD display of the Billing Trolley, where user can see the product information. The ARM 7 microcontroller also passes the data obtained from the database to the Zigbee transmitter from where the data is wirelessly transmitted to the billing computer. The master computer receives this data through Zigbee receiver using Max 323 interface. Max 323 interface is the interconnection media between the Zigbee receiver and the computer.

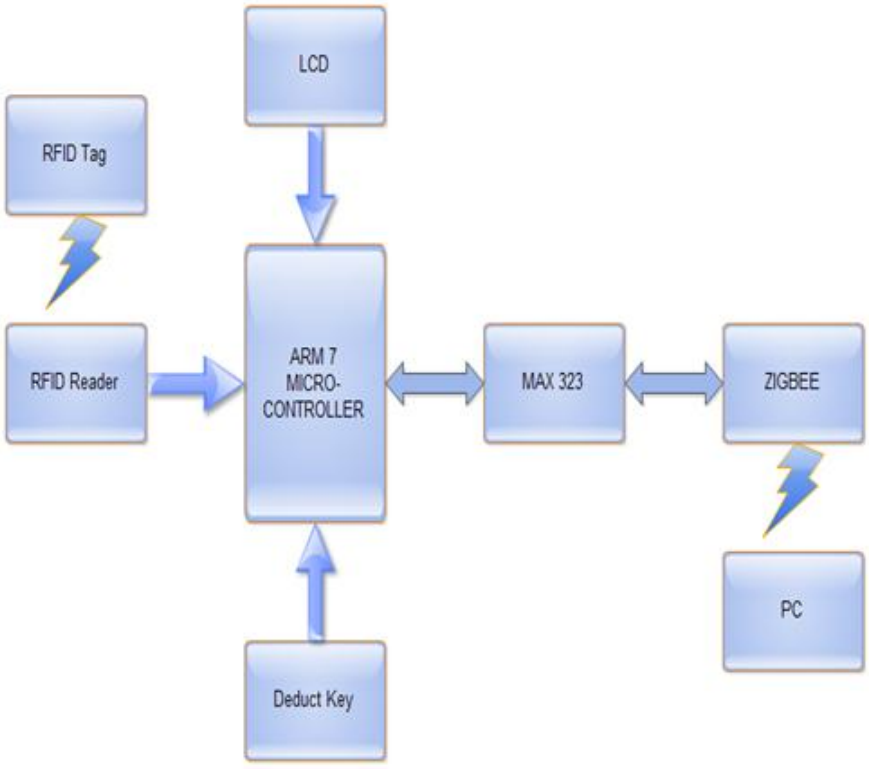

Fig 4.2: Block Diagram Of System At Trolley

V. System Design & Implementation

5.1. Design

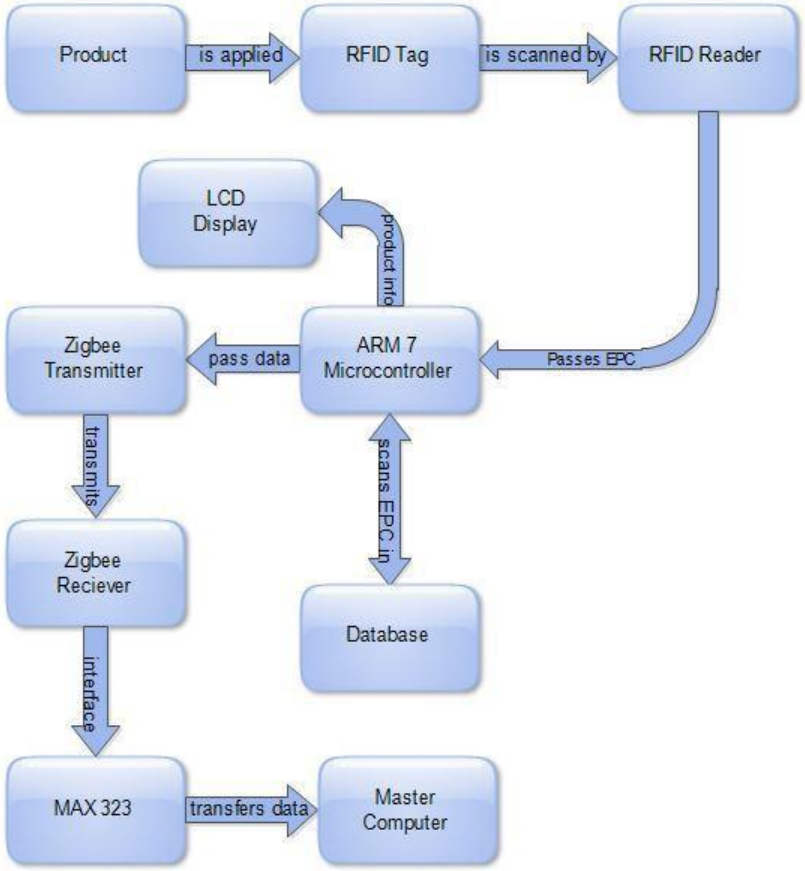

Fig 5.1: System Architecture

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The ARM7 microcontroller also passes the data obtained from the database to the ZigBee transmitter from where the data is wirelessly transmitted to the billing computer. The master computer receives this data through ZigBee receiver using Max 323 interface. Max 323 interface is the interconnection media between the ZigBee receiver and the computer.

5.2 Implementation

This paper mainly has 3 phases, reading the RFID tag, displaying the content on LCD and sending the content list to the main server at the billing counter. Reading of RFID and displaying the contents is done at server side and sending information like the cart number, bill details is done at the receiver side.

5.2.1 Reading Of The RFID Tag

In this phase, every product will be equipped with a RFID tag whose information will be stored in the microcontroller. When these tags are read through the RFID reader, the tags will be checked against the data stored in the microcontroller and if the tags match then it is displayed on the LCD.

In this phase, we see how the RFID tags inserted on the product is read. As shown in the figure, the RFID tag has to be activated for it to be read, only if the RFID tag is active it is read otherwise it will not be read. For a RFID tag to be active it has to be swiped. After the tag is active and swiped the tag is scanned by the

RFID reader which is connected to the microcontroller where the information of the entire product will be stored. This RFID reader passes this tag to the microcontroller and matches if the swiped tag ID is present in the database. The database would include the product information like the name and cost of the product

5.2.2 Displaying Of Content On Lcd Screen

When the tag is read in the previous phase then it will be compared to the value stored in the microcontroller, if the tags ID matches then the microcontroller will send the respective tag information to the LCD for display. The LCD displays the Product name and cost of the product.

In this phase, we mainly focus on the content to be displayed on the LCD screen after the tag is successfully verified. The data stored in the database is sent to the LCD to display. The format of the LCD can be defined by the user as to what information has to be displayed. In this paper we are only displaying the Product name, cost and the total cost of all the products in the trolley

5.2.3 Sending Billing Information To Main Computer

After all the shopping of the person, the total cost and products in the trolley will be sent to the main server with the help of ZIGBEE. The ZIGBEE transmitter will send the information from microcontroller and ZIGBEE receiver will collect the data and sends it the main computer at the billing counter.

In this module, we are transferring the information of the products and its total cost to the main computer which will be kept at the billing station.

VI. Module Description

6.1.1 Hardware Modules

6.1.1.1 P89V51RD2 Microcontroller

The main centre part of the paper is the microcontroller. Here we are using the 8051 based Philips P89V51RD2 microcontroller. The P89V51RD2 are 80C51 microcontrollers with 64kB flash and 1024 B of data RAM. A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (six clocks per machine cycle) to achieve twice the throughput at the same clock frequency.

The flash program memory supports both parallel programming and in serial ISP. Parallel programming mode offers gang-programming at high speed, reducing programming costs and time to market. ISP allows a device to be reprogrammed in the end product under software control. The capability to field/update the application firmware makes a wide range of applications possible.

6.1.1.2 16 X 2 LCD

A liquid crystal display is a thin, flat electronic visual display that uses the light modulating properties of liquid crystals (LCs). LCs does not emit light directly. In liquid crystal displays (LCDs) of liquid crystal technology is the most common applications. An advanced VGA computer screen from the pervasive wrist watch and pocket calculator, this type of display has evolved into an important and ambidextrous interface. Consist of a liquid crystal display, an array of tiny segments (called pixels) and to present the information that can be manipulated. This basic common idea is to all displays, alienate from simple calculators to a full color LCD television. The primary factor was size, an LCD consisting of primarily with some liquid crystal material between them of two glass plates. There is no bulk amount picture tube. This gives LCDs practical for applications where size (as well as weight) is necessary. In general, LCDs uses very low power than the cathode-ray tube (CRT) counterparts. Many LCDs are ruminative, means that they use only atmosphere light to illuminate the display. Even displays that do consume much less power than CRT devices require an external light source (i.e. computer displays).Make sure that 5V and GND lines are properly connected otherwise you may end up in damaging parallel port. If you want backlight than connect pin 15 of LCD to 5V and pin 16 of LCD to GND. By adjusting 10k resistor make pin 3 of LCD at 0V. If connections are proper you will see this after power on.

6.1.1.3 MAX232 Interface

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels.

6.1.1.4 Radio Frequency Identification (RFID)

Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. The technology requires some extent of cooperation of an RFID reader and an RFID tag. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. An RFID tag is an object that can be applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader. Electronically programmed with unique information. There are many different types of RFID systems out in the market. They are categorized according to their frequency ranges. Some of the most commonly used RFID kits are as follows-

- Low-frequency (30 KHz to 500 KHz)
- Mid-Frequency (900KHz to 1500MHz)
- High Frequency (2.4GHz to 2.5GHz)

These frequency ranges mostly tell the RF ranges of the tags from low frequency tag ranging from 3m to 5m, mid-frequency ranging from 5m to 17m and high frequency ranging from 5ft to 90ft. The cost of the system is based according to their ranges with low-frequency system ranging from a few hundred dollars to a high-frequency system ranging somewhere near 5000 dollars.

A basic RFID system consists of three components:

- An antenna or coil
- A transceiver (with decoder)
- A transponder (RF tag)

Antenna

The antenna emits radio signals to activate the tag and read and write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system's data acquisition and communication. Antennas are available in a variety of shapes and sizes; they can be built into a door frame to receive tag data from persons or things passing through the door, or mounted on an interstate tollbooth to monitor traffic passing by on a freeway. The electromagnetic field produced by an antenna can be constantly present when multiple tags are expected continually. If constant interrogation is not required, a sensor device can activate the field.

Often the antenna is packaged with the transceiver and decoder to become a reader (a.k.a. interrogator), which can be configured either as a handheld or a fixed-mount device. The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

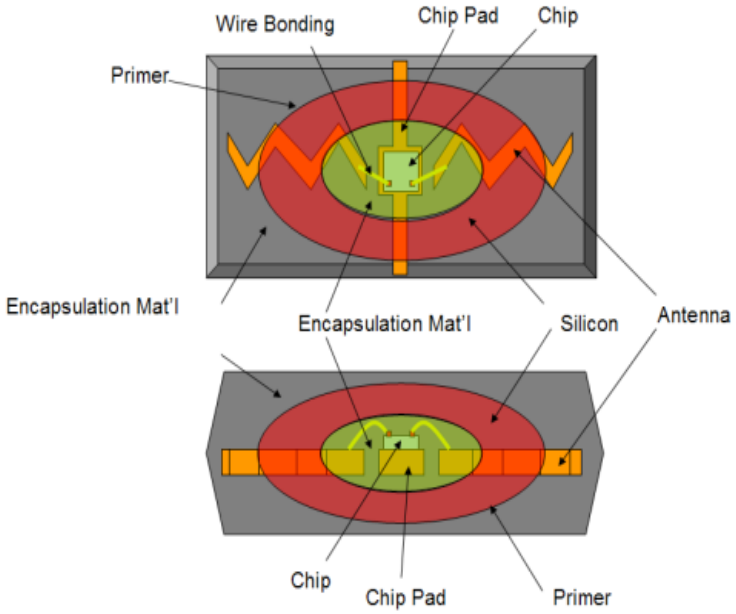

Fig 6.8: RFID Tag Components

Transceiver

RF Transmitter: The RF transmitter and receiver are used both in the control unit as well as in the robotic module. The RF transmitter and receiver in the transmitter and receiver module respectively operate at the frequency of 433MHz and the transmitter and the receiver module in the robotic module and the control unit respectively operate at the frequency of 316MHz.

The RF transmitter in the control unit is used to transmit the signals which control the robotic module's operations. The control signals for the gear motors through the motor drivers, the firing unit and the voice transmission unit through the ground driver circuit and the request to SONAR for the distance measurement is also sent through this transmitter. The transmitter in the robotic module is used to transmit the distance calculated by the SONAR to the controlling unit. The figure below shows the pin out diagram of the RF transmitter.

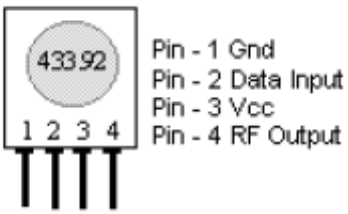

Figure 6.9: RF Transmitter TWS 434

Some of the features of transmitter IC TWS 434 are,

- Frequency: 433.92MHz
- Modulation: AM
- Operating voltage: 4.5 – 5.5 VDC
- Output: Digital & Linear

RF Receiver

The RF receiver in the transmitter module receives the distance related information transmitted by the robotic module. The microcontroller is used to display the distance on the LCD module. The receiver in the robotic module receives the control signals transmitted by the control unit which are used to control various functions of the robot. The figure below shows the pin out diagram of the RF receiver.

TAGS (Transponders)

An RFID tag is comprised of a microchip containing identifying information and an antenna that transmits this data wirelessly to a reader. At its most basic, the chip will contain a serialized identifier, or license plate number, that uniquely identifies that item, similar to the way many bar codes are used today. A key difference, however is that RFID tags have a higher data capacity than their bar code counterparts. This increases the options for the type of information that can be encoded on the tag, including the manufacturer, batch or lot number, weight, ownership, destination and history (such as the temperature range to which an item has been exposed). In fact, an unlimited list of other types of information can be stored on RFID tags, depending on application needs. An RFID tag can be placed on individual items, cases or pallets for identification purposes, as well as on fixed assets such as trailers, containers, totes, etc.

VII. Conclusion and Future enhancement

From this paper, we would like to highlight that we drew the inspiration and idea of this paper after observing the long queues at the sales and billing counters at the shopping malls and retail bazaars. The intended objectives were successfully achieved in the prototype model. The developed product is easy to use, low-cost and does not require any special training. This paper reviews and exploits the existing developments and different types of radio frequency identification technologies which are used for product information, billing, etc. We have also learned the architecture of the system that can be used in the shopping systems for intelligent and easy shopping in the malls to save time, energy and money of the consumers. This system would help in cost saving at the supply chain level. At the same time it would also reduce the required no of salesmen. Thus it is truly time saving method and guarantees the less time consumption out of all present billing methods. The future of this system is very bright and progressive as it is key to cost savings and efficient management. Wireless futuristic trolleys can be integrated with Wi-Fi systems or for that matter even with the internet. In this way it would ensure a truly, electronic global supply chain management & inventory management. Moreover the scope can be expanded even more with slight modifications in following ways:

This technology can be used at airports because of its wireless nature and its ability to ensure better security. With certain modifications it can be used to track movement of containers on docks and ports.

With the advent of futuristic systems, trolleys will eventually replace salesmen, hence helping in reducing final product of goods. As a result, better and more profit margin. Global sales monitoring and inventory control from a geographically far off site. There are a few challenges/drawbacks that can be resolved to make proposed system more robust. This issue will have to be resolved specifically with respect to billing to promote consumer confidence. Further, a more sophisticated microcontroller, larger display system, GPS to track the product, internet facility inside the card to browse the offers, deals and facility of payment within the cart by using swapping card can be used to make cart more advance provide better consumer experience.

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