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Intelligent Shopping Cart

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Abstract*— An innovative product with societal acceptance is the one that aids the comfort, convenience and efficiency in everyday life. Purchasing and shopping at big malls is becoming daily activity in metro cities. We can see big rush at these malls on holidays and weekends. People purchase different items and put them in trolley. After completion of purchases, one needs to go to billing counter for payments. At billing counter the cashier prepare the bill using bar code reader which is very time consuming process and results in long queue at billing counter. In this paper, we discuss a product "Intelligent Shopping Cart" being developed to assist a person in everyday shopping in terms of reduced time spent while purchasing. The main objective of proposed system is to provide a technology oriented, low-cost, easily scalable, and rugged system for assisting shopping in person. The developed system consists of 3 key components/modules (a) Server Communication component (SCC) (b) User Interface and display component (UIDC), and (c) Automatic billing component (ABC). SCC establishes and maintains the connection of the shopping cart with the main server. UIDC provides the user interface and ABC handles the billing in association with the SCC. These 3 modules are integrated into an embedded system and are tested to satisfy the functionality. The prototype developed is ready for commercial deployment with proper attention to security and network issues as discussed.

***Index Terms*— EM-18 RFID Reader, LPC2148 Microcontroller, RFID tag Radio Frequency Identification (RFID), ZigBee Module.**

I. INTRODUCTION

Innovation in communication and information technologies have caused a revolution in values, knowledge and perceptions in practically all areas of human understanding, deeply carving the so-called "Age of Information and Knowledge".Human beings have invented/adopted technology to their needs since their existence. Main purpose of innovation in technology, irrespective of the domain, has been in simplifying life on earth or making everyday's work easier and faster. One regular task that human beings spend considerable amount of time is in shopping. According to a survey conducted by US Bureau of Labour [10], on an average, human beings spend 1.4 hours every day on shopping. A survey done by Visa in 2005[11], points out that an amazing 70% customers will walk out of a queue if the line is too long, and 10% are "seriously annoyed" the moment they step in a queue. Further, according to a study conducted by CISCO Internet Business Solution Group [12], the top four reasons for shoppers to use technology are to (i) Find best price (63%), (ii) Save time (47%), (iii) Find best assortment (26%) and (iv) find best quality (25%). The current scenario on shopping classifies it into two categories (1) Shopping in-person and (2) Shopping in absentia. Shopping in absentia is facilitated in multiple ways including, internet shopping, tele-shopping, etc. wherein a shopper does not have to be physically present in the shopping area. Shopping in-person typically involves a personal visit to the place of shopping and selecting the product/s based on various parameters including need, convenience, brand, discount/offer, etc. The proposed system intends to assist shopping in person that will minimize the time spent in shopping as well as intended to aid the store management with real-time updates on the inventory. The emergence of new technologies, such as Radio Frequency Identification (RFID) and wireless networks, makes the shopping processes faster, transparent and efficient. Our aim is to develop an intelligent shopping cart (embedded system) which can be used in shopping malls to solve the problem mentioned above. The Intelligent Shopping Cart is equipped with Radio Frequency Identification (RFID) for product identification and a consistent Wi-Fi connection with the shop's server. Besides, it also has an LCD display that informs customers about product prices, discounts, offers and the total bill. As soon as the object is dropped into or removed from the cart, the RFID tag identifies the product and updates the bill. When the customer is done with shopping, he can just press the 'End shopping' button and the details are sent to the shop's server and the customer has to pay just the amount and leave. "This shopping cart will change the way people shop as radically as ATM's changed banking." The proposed cart is easy to use and does not need any special training. The cart's inbuilt automatic billing system makes shopping a breeze and has other positive spin-offs such as freeing staff from repetitive checkout scanning, reducing total number of staffs required and increasing operational efficiency of the system. In this paper, we discuss the System Design, Implementation, Testing, and Conclusions. In conclusions we also discuss about opportunities of improving the proposed system to make it into a commercially viable product as

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an excellent way to help customers reduce the time spent in shopping by displaying the list of products, their cost, the best deals/rates on the products and automatic billing. The system helps the store management with an automatic update of the inventory on every purchase of an item Intelligent shopping cart (proposed system) has the potential to make shopping more pleasurable and efficient for the shopper and the inventory control easier for the store management. Intelligent shopping cart (proposed system) has the potential to make shopping more pleasurable and efficient for the shopper and the inventory control easier for the store management. The remainder of this paper is organised as follows. The related work is discussed in chapter 2. Chapter 3 details our proposed model. Chapter 4 includes algorithm & flowchart. Results are shown and discussed in chapter 5.Chapter 6 draws the conclusions.

II. RELATED WORK

While doing survey we found that most of the people prefer to leave the shopping mall instead of waiting in long queues to buy a few products. People find it difficult to locate the product they wanted to buy, after selecting product they need to stand in a long queue for billing and payment.

To try to solve the problems previously identified, recent years have seen the appearance of several technological solutions for hypermarket assistance. All such solutions share the same objectives: save consumer's time and money, help the retailers to win loyal clients.

Satoru Uehara et. al., [14] defined the Web shopping cart system as a typical client-server application on the Web. Then they clarified several problems on the implementation of the Web shopping cart system, which are peculiar to the Web. In order to solve the problems, He proposed a new mechanism that can manage user sessions with high reliability and safety. He compared the Web shopping cart system implemented using the proposed mechanism with the one developed by the conventional methods.

Chihhsiong Shih, et al., [13] proposed an automatic embedded software generation framework that can create and evolve Zigbee applications. The framework consists of two major modules, pattern extraction and code generation. Pattern extraction and development are designed to provide Zigbee application with model reuse and modification. SysML serves as a medium between pattern development and code generation. State diagrams, class diagrams and sequence diagram help describes a specific application scenario. A smart shopping cart application has been implemented using this pattern based software framework.

III. PROPOSED MODEL

Here, we discuss a novel product "Intelligent Shopping Cart" being developed to assist a person in everyday shopping in terms of reduced time spent while purchasing a product at the best price available. The main objective of this is to provide a technology oriented, low-cost, easily scalable, and rugged system for assisting shopping in-person. The developed system consists of 3 key components/modules (a) Server Communication component (SCC) (b) User Interface and display component (UIDC), and (c) Automatic billing and Inventory management component (ABIMC). SCC establishes and maintains the connection of the shopping cart with the main server. UIDC provides the user interface and ABIMC handles the billing and inventory management in association with the SCC. These 3 modules are integrated into an embedded system and are tested to satisfy the functionality. The main technological objective for our presented solution is the usage of RFID technology for the automatic product identification inside the shopping cart thus eliminating consumer intervention in the process of product reading for payment. Nowadays, the usage of barcode for product identification presents several limitations: only the product's class is identified; information is static; allows one single reading at a time; requires line-of sight; has low range and security. RFID technology is more resistant, safer, identifies products in a unique way, can provide other types of information, can make several simultaneous readings, doesn't need line-of-sight and it has a high range. So that automatic product identification is possible all existing products inside the supermarket need to be identified with RFID tags and each shopping cart must have an RFID reader. The range of the RIFD reader must not extend beyond the horizontal shopping cart limits so that reading products inside other shopping carts or on shelves does not happen. Nevertheless, range cannot be less than the cart's limits with consequence of not identifying products that are inside the shopping cart but out of the reader's range. Vertically, the reader should be able to identify products down to the floor, since there are shopping carts where you can place products from 20 cm above the ground and to about 1,5 m higher than the handle bar since there are both tall products and excessively filled carts. The RFID reader should be able to read all the tags no matter the material (paper, plastic, metal, etc) they are inserted into. By suggesting a single RFID reader per cart, we are thinking not only in terms of costs, battery

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duration and data quantity but also in preventing colliding readings in cases when more than one reader is used, something which increases the complexity level.

The usage of RFIDs in this system comprehend benefits such as increasing safety and the consequent reduction in product loss, reduced human intervention and error, increased speed in involved processes, unique identification of products with additional information and availability of real time information, amongst others. Besides the advantage of accessing real-time information about the diverse products inside the shopping cart, the client can also be helped by the navigation system, meaning that they can be guided through the supermarket avoiding time losses that occur when searching for products in unknown locations. Through the interactive map that shows product location and the shopping cart's current position, it is then possible to follow the route indicated by the map to reach the desired product. There will be immediate updates of the cart's position any time it is moved by the consumer. To make this possible, a shopping cart positioning technology is required in several Supermarket locations so that the permanent monitoring enables real-time cart position updates. The choice of a positioning technology to our solution is particularly difficult because of the diverse characteristics each technology presents. Aspects such as range, energy consumption, safety, precision, amongst others, are important for our solution. Yet, the optimal characteristics are not gathered in one single technology, Because of this, we have chosen to identify the requisites our solution demands and to suggest the technologies most likely to serve its purposes. The necessary requisites for the proposed system are as follows: (Refer Table I.)

Table I. RFID characteristics

Frequency	Mode	Range	Transfer Rate	Penetrating Capability
125-135kHz	Passive	Short range (upto 0.5m)	Low	Liquid
13.56MHz	Passive	Medium range (upto 1.5m)	Moderate	Liquid
860-930MHz	Passive	Medium range (upto 5m)	Moderate to High	Liquid and Metal
433MHz	Active	Ultra long (upto 100m)	High	Liquid and Metal
2.45GHz	Active	Long range (upto 10m)	Very High	Liquid and Metal

Frequency should be Middle range, so that a considerable area is comprised thus preventing the usage of an exaggerated number of locating devices, The system must consume low energy, so that the shopping cart doesn't run the risk of rapidly running out of energy, Warrantable and safe connection and signals must be strong enough so it remain unaffected by obstruction, especially metallic objects.

Maximum automation of location processes and tracking of any shopping cart featuring the location device inside range and angle positioning technologies such as WLAN, Bluetooth, RFID and Indoor GPS have a larger range and neither requires line-of-sight nor depends on angles. Besides that, they consume little energy are not expensive. The RFID or Wi-Fi based RTLS also appears to be a good choice. The choice will also depend on the environment of the application, establishment requisites (if existing infrastructures are used or not) and budget amongst others, but never forgetting that the elected technology should obey to the above mentioned requisites. Regardless of the Positioning technology used for this solution, each shopping cart should have a location transmitter. Also the supermarket should have the necessary number of receptors to cover its entire area. All the electronic equipment featured by the shopping cart should be prepared for hostile environments, accounting for scratches, beatings, dirt, liquids, etc. This equipment can also be prepared for parking lots where atmospheric conditions can affect the cart. Nevertheless, this decision will have to be made by each supermarket, since they are the ones that must take their own security measures so that the equipment is not stolen. All system communication should be trustworthy and safe, since personal client data will be transmitted. Clients will therefore have to fully trust the system so that they will use it regularly. The system should also be easily integrated with all kinds of technologies used by the previously existing retailers' systems. Lastly, but not least importantly, the necessary energy for the client's optimal system usage should be minimized, since energy cannot fail during the process. One way to save batteries is to suspend the system while it is on stand-by.

In the proposed system, if the object is dropped into or removed from the trolley, the RFID tag identifies the product and updates the bill. After shopping, if we press the 'End Shopping' button and the details are sent to the master computer and the customer has just to pay the amount and leave the mall, which saves the precious time of the consumers. The block diagram of proposed system is shown in figure 1 & 2 below.

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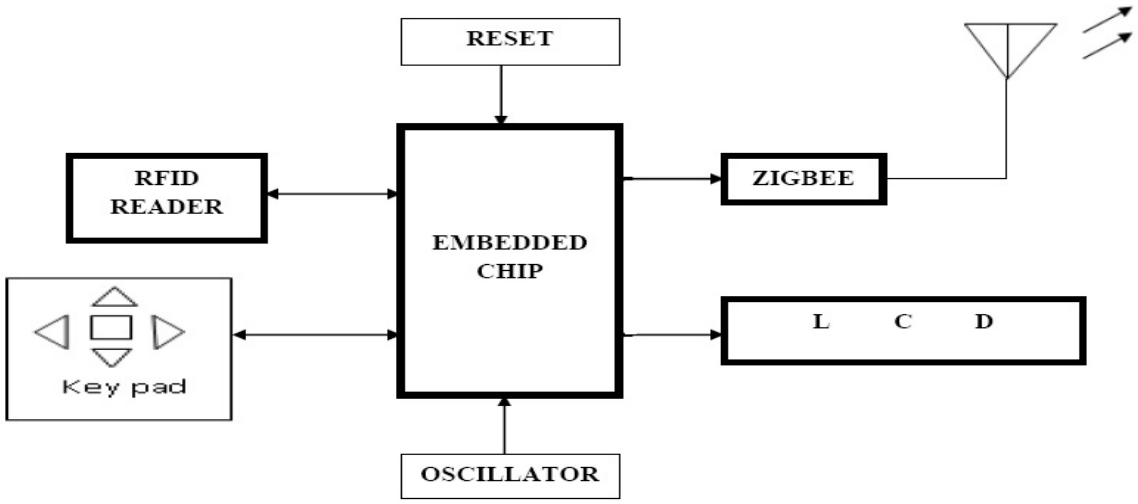

Fig. 1 Block diagram of Trolley Section

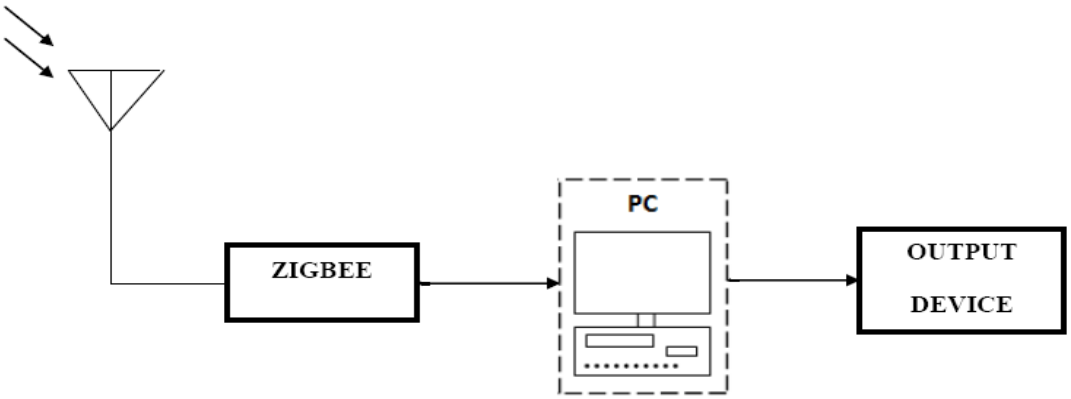

Fig. 2 Block diagram for billing section.

The integrated system is built around LPC2148 Microcontroller and has 16X2 LCD display, ZigBee module, RFID module & miscellaneous circuit including power supply. The operation of RFID reader & ZigBee is performed via UART, the proposed system components and system model is shown in figure 3.

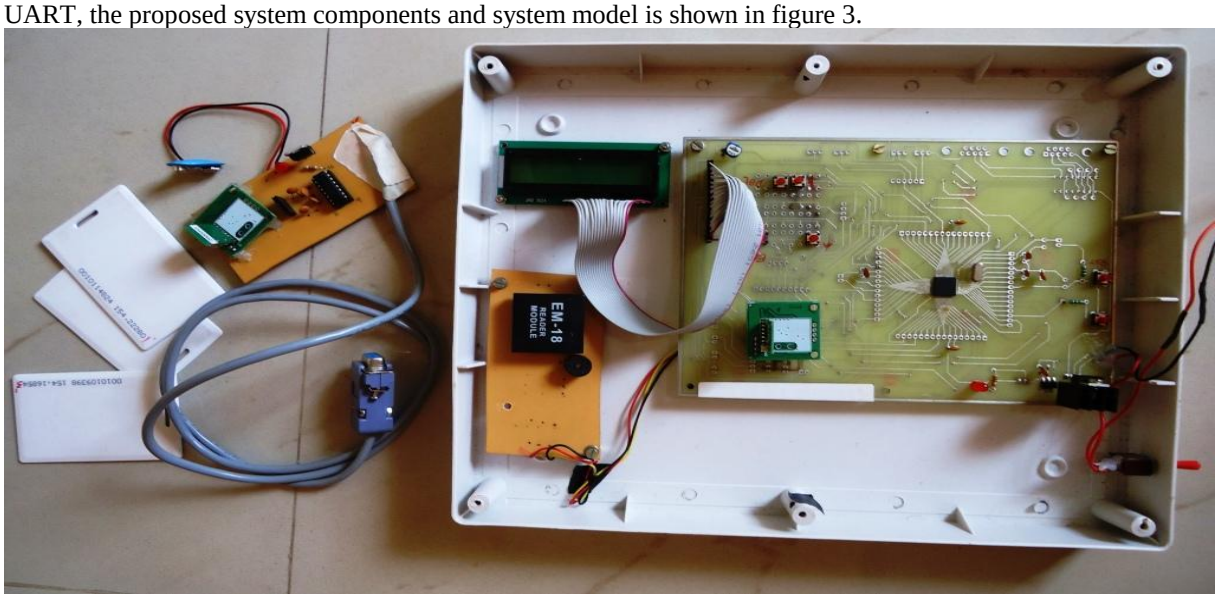

Fig. 3 System Components.

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IV. ALGORITHM

Problem definition: when any selected prodcut is dropped in into the cart, RFID reader the reads the tag inside the prodcut and the information of the product is extracted and displayed on the LCD screen. At the same time billing information is also updated.The working of the Intelligent Shopping Cart can be explained with 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 unique id. These Ids are fed in the database assigned to the corresponding products.

3) When the shopper drops any product in the cart then the RFID reader reads the tag. The information of the product is extracted and displayed on the LCD screen. At the same time billing information is also updated.

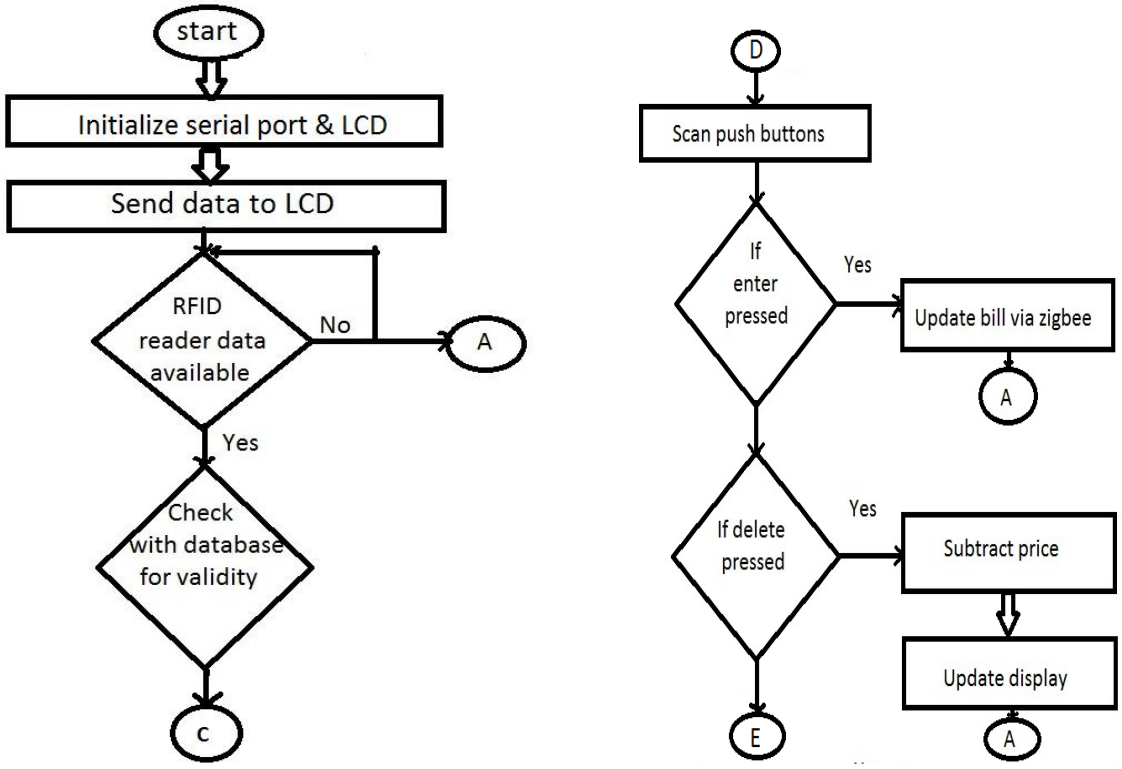
4) These steps are repeated until the end of shopping button is pressed. Once the "End Shopping" button is pressed the total bill is send to master pc via Wi-Fi (ZigBee).

5) There is also a 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.

Flowchart:



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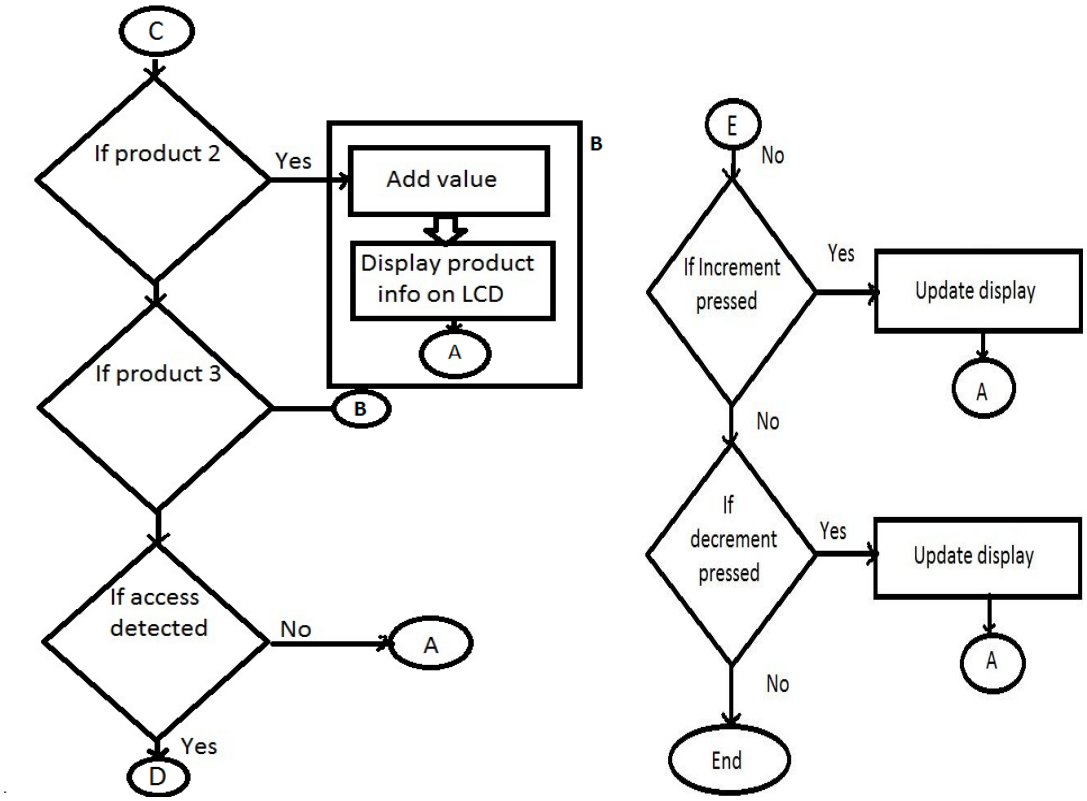

V. RESULTS & PERFORMANCE ANALYSIS

Unique RFID tags given in table II are used to indicate distinctive products being shopped. As the RFID card reader read the product, details were displayed on the display unit. The product details of the shopped items were temporarily stored in the local memory. Once the shopping "Complete" button was pressed, the memory contents were read and billing was done. The same product information data was sent back to the server to update the inventory.

Table II. Sample Database of product details.

RFID TAG ID	PRODCUT NAME	PRICE
222801	SOAP	Rs 10
257082	RICE	Rs 20
168543	No name assigned	Used for confirmation

The following test case scenarios were used in the integrated system testing to prove the working of the developed system.

a) Shopping cart and server communication using the wireless ZigBee module
b) Identifying items based on RFID tags and synchronizing with central database.
c) Automatic billing
d) Display the product name & price.
e) Complete listings of the products along with their price on LCD display.
f) Update inventory in the central system upon each purchase of a product.
g) Automatic billing update when the products are dropped in the cart or removed from the cart.
h) Display of total bill on the master pc.

All test cases were successfully tested. The system developed is user friendly and no special training is required to use the cart.

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Table III. Comparison between BARCODE & RFID system

BARCODE (existing technology)	RFID (proposed technology)
a) Person is required to read barcode on product. b) Barcode must be visible on the surface of product. c) Line of sight required to a read barcode. d) The readability of barcodes can be impaired by dirt, moisture, abrasion, or packaging contours e) Short reading distance. f) Barcode does not have READ & WRITE capability.	a) Automatic reading of RFID tag from product. b) RFID can be placed inside the product. c) No line of sight required to read RFID. d) RFID tags are not affected by such conditions. e) Long reading distance. f) RFID tag having READ & WRITE capability.

Table IV. Comparison between existing system & proposed

Existing system	Proposed system
a) Manual billing. b) Use barcode for billing c) human staff is needed for billing d) Low product cost but overall expenses are much high. e) Difficult to track the product. f) Getting product information is difficult & time consuming. g) It does not disclose any automatic way of indicating to the shopper how the total bill is affected as objects are added or removed from the cart.	a) Automatic billing b) Use RFID TAG for billing c) No need of any staff for billing d) Product is little expensive but overall expenses is much low e) Easy to locate/track the product f) Getting product information is easy and no extra time needed. g) LCD display is present which will show the updated bill every time the shopper add or remove any object from the cart.

VI. CONCLUSION

The intended objectives were successfully achieved in the prototype model developed. The developed product is easy to use, low-cost and does not need any special training. This project report reviews and exploits the existing developments and Different types of radio frequency identification technologies which are used for product identification, 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. Present trends point towards the fast growth of RFID in the next decade. With around 600 million RFID tags sold in the year 2005 alone, value of market including systems, services and hardware is likely to grow by factor of 10 between years 2006 -2016. It is expected that total number of RFID tags delivered in the year 2016 will be around 450 times as compared to the ones delivered in the year 2006.

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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APPENDIX

Snapshot of developed model and result obtained.